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THE PLACE OF ORIGIN AND RECURVATURE OF TYPHOONS

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(NOTE.—This paper constitutes the concluding section of Dr. Coching Chu's paper "A new classification of the typhoons of the Far East," begun in the December, 1924, number of the MONTHLY WEATHER REVIEW.)

In order to ascertain the zones of formation of typhoons, it is necessary to have a network of meteorological stations in the region of the Caroline and Ladrone Islands. Such stations are not available to-day, nor are they likely to be in the near future. In the following discussions, therefore, the zone of formation of typhoons can only be approximately indicated. The Weather Bureau stations at Guam, in the Ladrone Islands, and at Yap, in the Carolines, were established in June, 1904,[1] the first year of the period with which this paper deals. The importance of these two stations can not be overemphasized. The observers there cable warnings to the Manila Observatory whenever the pressure indicates the exist ence of a typhoon, or the development of one. They serve as the advance guards to protect the eastern coast of Asia, Japan, and the Philippines from the sudden invasion of a destructive cyclone. These warnings were regularly transmitted to the Manila Observatory until lately, when owing to the war the reports have stopped.[2]

The Philippine Weather Bureau, having in its possession the reports from Guam and from Yap, can determine the latitude and longitude of origin of many storms with more or less accuracy. The Japanese weather service does not trace the typhoons to their origin, but plots only that portion of the tracks which is north of latitude 20° N. The place of origin is usually determined by the wind directions and pressure oscillations observed at Guam (lat. 13° 26′ N., long. 144° 40′ E.) and at Yap (lat. 9° 29′ N., long. 139′ E.).

The latitude and longitude of origin and recurvature of the typhoons of the period 1904–1915, taken mostly from the Manila *Monthly Bulletin*, have been computed, and three tables have been prepared. Table 6 shows the average location of the origin and of the recurvature of the typhoons of the different months. The data given by Father Algué have also been tabulated for the sake of comparison. Table 7 gives the number of typhoons and depressions of each month which originated in different latitudes. Table 8 gives the average location of the origin and of the recurvature for the different types of typhoons.

The latitude of origin moves northward from May, when it is 13° 20′ N., to August, when it is 16° 05′ N. It then decreases until December, when it is 8° 30′ N. The number of storms in the months of January to April, inclusive, is too small to obtain a good average, but the latitude of origin probably remains as low as that of December, if it is not still lower. The storms originate farther to the west as the season advances from January to June, when the zone of formation begins to shift eastward until the month of December. As a whole, the average longitude and latitude of origin for the different months as calculated from the 247 typhoons observed during the period 1904–1915 agrees very well with the limits set by Father Algué.

The vertex of the parabolic tracks of typhoons reaches the highest latitude in the month of July, and, like the origin, it goes farther toward the west in June than in any other month.

From Table 7 we see that 253 cases out of 303 cyclones and depressions originated between lats. 8° to 20° N. This is 85 per cent of the total. The lowest latitude in which a storm appeared during the period 1904–1915 is lat. 2° N. This happened in the storm of December 2–4, 1909.[3] The highest latitude in which a tropical storm originated during the same period is lat. 25° N. This typhoon occurred in August 3–8, 1909.[4] If it were not for the fact that the storm went westward, it might have been taken as an extratropical storm, for it traveled in a remarkably high latitude. Originating in lat. 25° N., long. 149° E., it traveled westward, crossing the Island of Kiusiu and entering China near latitude 35° N. The average latitude of origin of 303 typhoons and depressions which have been studied is 13° 40′ N.

Concerning the origin of typhoons, Father Chevalier said:[5]

> There are typhoons which originate in the China Sea, but there are very few, and they will be pointed out as exceptions to the trajectories regularly followed. Very commonly the typhoons originate east of the Philippines, in the square roughly included within the meridians 125° to 145° east of Greenwich and the parallels 10° and 25° north. Whether they originate further eastward is not sure, but it is rather probable. But if there are some, they do not come so far westward as to make their appearance either on the Chinese or the Japanese coast.

Father Algué, after quoting the same statement, added:[6]

> Generally speaking, there are many typhoons which form in a lower parallel than 10° N. and very few in a higher parallel than 20° N. somewhere to east-northeast of Luzon. With regard to the longitudinal limit of formation assigned by Father Chevalier, we judge it to be sufficiently approximate for those of which he speaks, as well as those which are experienced here in the Philippines and in Japan. This refers chiefly to the cyclones which are some way or another felt in the Philippines. If we take into consideration the cyclones which we classify in chapter 10 as cyclones of the Marianas and Magallanes, type 5a, we can extend the limits in longitude for the cyclones formed in the Pacific to meridian 125°–152° east of Greenwich.

From Table 7 we see that out of 303 storms only 1 originated at or above lat. 25° N., while 65, or 21 per cent of the total, originated below lat. 10° N. Therefore, as is pointed out by Father Algué, Father Chevalier's lower limit of the latitude of origin is too high. Father Chevalier was doubtful whether typhoons ever originated

[1] Monthly Bulletin of the Philippine Weather Bureau, September, 1905, p. 378.
[2] This paper was written before the ending of the European war.
[3] Monthly Bulletin of the Philippine Weather Bureau, December, 1909.
[4] *Loc. cit.*, August, 1909.
[5] S. Chevalier, *Loc. cit.*, p. 88.
[6] J. Algué, *loc. cit.* p. 23.

east of long. 145° E. The following table, computed from 247 typhoons observed during the years 1904 to 1915, throws some light on the subject.

	January	February	March	April	May	June	July	August	September	October	November	December	Total
Number of typhoons observed during the period 1904–1915	3	1	6	4	11	13	39	51	46	36	22	15	247
Number of typhoons originating east of longitude 145° E	----	----	1	1	----	1	1	9	15	8	4	3	43
Percentages	----	----	----	----	----	8	3	18	33	22	18	20	17

In the average for the year about 17 per cent of the typhoons originate east of long. 145° E. During the month of September, the percentage is very high; almost one out of three starts from a region east of long. 145° E. There were two cases of storms which formed east of long. 160° E. The first occurred April 20–30, 1905. It originated in the neighborhood of lat. 7° N. and long. 163° E. The natives of the eastern Carolines pronounced it the worst typhoon they had seen, as cyclones generally originate between the east and the west Carolines. On the island of Ascension, 15 persons were killed, and out of 2,150 houses on the island only 1 remained standing after the storm.[7]

TABLE 6.—*Positions of origins and recurve of typhoons in different months*

[Calculated from the 247 typhoons of the period 1904–15]

	Origin		Recurve [1]	
	Latitude	Longitude	Latitude	Longitude
	° ′	° ′	° ′	° ′
January	8 00	145 00	----	----
February	7 00	----	12 00	136 00
March	6 30	141 30	15 30	134 00
April	8 50	136 10	----	----
May	13 20	125 40	18 10	123 00
June	14 55	124 30	23 40	120 00
July	15 00	133 50	28 00	121 55
August	16 05	137 00	25 50	127 30
September	14 40	137 30	24 20	128 50
October	11 30	137 00	24 40	139 50
November	10 10	139 30	20 00	129 00
December	8 30	142 30	16 20	128 30

	Origin [2]		Recurve,[2] latitude
	Latitude	Longitude	
December, January, February, March	5°–12°	143°–145°	15°–19°
April, May, October, November	6°–17°	129°–142°	16°–21°
June, July, August, September	8°–20°	126°–139°	21°–25°

[1] Compare with results given in Louis Froc. *loc. cit.*, Table 3.
[2] Algué, *loc. cit.*, p. 23.
[3] *Loc. cit.*, p. 79.

TABLE 7.—*Latitude of origin of typhoons and depressions observed during the period 1904-1915*

Latitude	25°+	20–25	18–20	16–18	14–16	12–14	10–12	8–10	5–8	5–0	Total
Month											
January	----	1?	1?	----	----	----	----	1	----	----	3
February	----	----	----	----	----	----	----	1	1	----	2
March	----	----	----	1?	----	----	----	2	3	----	6
April	----	----	----	----	----	----	1	4	1	----	6
May	----	----	2	2	5	1	4	2	1	----	17
June	----	2	----	5	3	4	2	1	----	----	17
July	----	1	4	9	8	7	1	1	----	----	31
August	1	9	15	8	12	6	3	6	2	----	62
September	----	7	8	14	8	11	11	4	3	----	66
October	----	----	----	2	8	10	13	4	5	----	42
November	----	1	1	1	----	6	11	5	6	----	31
December	----	----	2	----	1	1	4	6	5	1	20
Total	1	21	33	42	45	46	50	37	27	1	303

[7] Monthly Bulletin of Philippine Weather Bureau, April, 1905.

TABLE 8.—*Mean positions of origin and recurve for different types of typhoons*

Type of typhoon	Origin			Recurve		
	Latitude N.	Longitude E.	Number of cases	Latitude N.	Longitude E.	Number of cases
	° ′	° ′		° ′	° ′	
1a	16 45	142 40	3	33 30	118 00	2
1b	15 45	137 50	27	27 30	116 00	5
1c	11 50	140 55	17	26 45	114 30	4
1d	18 20	116 50	7	22 00	114 00	1
2a	14 45	141 00	40	25 20	128 30	32
2b	13 30	145 30	1	19 00	122 00	1
2c	13 40	140 50	11	29 45	124 00	7
2d	19 45	118 15	4	----	----	----
3a	12 45	140 30	5	----	----	----
$3b_1$,[1] $3c_1$	12 30	133 00	12	22 30	106 00	1
$3b_2$,[2] $3c_2$	8 00	136 00	11	----	----	----
3d	17 00	116 30	7	----	----	----
4a	11 30	130 45	5	----	----	----
4b	7 20	142 30	9	----	----	----
4c	10 15	142 20	10	17 45	117 50	7
4d	----	----	----	----	----	----
5a	13 30	144 20	40	21 20	134 30	34
5b	16 30	136 00	10	22 10	125 50	6
5c	9 50	142 00	7	16 55	125 20	6
5d	17 10	117 00	7	24 00	123 00	1

[1] $3b_1$, typhoons of Gulf of Tongking passing through Luzon.
[2] $3b_2$, typhoons of Gulf of Tongking passing through Visayas and Mindanao.

The second storm was also a notable one. It occurred on March 29–April 1, 1907, and was known as the Easter storm, as Easter of that year fell on March 31. It originated in the vicinity of lat. 5° N., long. 160° E. At 10 a. m. on March 29, the barometer on the Wlea Island, in the west Caroline group, stood at 691.89 mm., or 27.24″. The decrease of pressure in 24 hours from 10 a. m. of the 28th to 10 a. m. of the 29th was 62.5 mm.[8] The settlements on the island of Wlea were completely destroyed and 200 persons were killed.[9]

If the 43 typhoons that originated east of long. 145° E. are classified according to their type, we have the following result:

Type	1b	2a	5a	All others
Number of typhoons during years 1904 to 1915	28	45	42	132
Number of typhoons originating east of longitude 145° E	6	12	16	9
Per cent of the total	21	27	38	7

The above table shows that the percentage of storms of type 5a (which Father Algué calls the cyclones of Magallanes or Marianas) that originated east of long. 145° E. is very large, while the percentages of the typhoons of types 1b and 2a were also greater than the average, which is 17 per cent. It also proves that Father Chevalier's statement that storms which originate farther eastward than long. 145° E. do not come so far westward as to make their appearance either on the Chinese or Japanese coast is not well founded.

Turning to the typhoons that have their origin in the China Sea, the result obtained from the study of 247 typhoons which occurred during the years 1904 to 1915 agree with Father Chevalier's statements that these storms are very few in number as compared with those which originate in the Pacific. Only about 10 per cent of all these typhoons are formed in the China Sea, according to the data given in Table 8. Doberck seems to have given the typhoons that originated in the China Sea too large a percentage. Table 2 is a summary of the classification given by Doberck in "The Law of the Storms in the Eastern Seas."[10] Types 1a, 1c, 1d, and 4a of Do-

[8] J. Hann, *loc. cit.*, pp. 607–608.
[9] Monthly Bulletin of the Philippine Weather Bureau, March, 1907.
[10] Hongkong, 1898, pp. 33–35.

berck all originate in the China Sea, and make up altogether 24.5 per cent of the total, which is two and one-half times as many as the percentage computed from Table 8 of the present paper. This discrepancy is very likely due to the fact that Doberck often reckoned the typhoons that form in the Pacific and enter the China Sea by crossing Visayas and Mindanao as storms that originate in the China Sea. Father Algué states in "Cyclones of the Far East:" [11]

In the trajectories published by the Hongkong Observatory we frequently find typhoons which appear to be formed in the China Sea to the northwest or north of Prague, between the 10th and 14th parallels; but remembering the notices of typhoons given by our observatory, it will easily be seen that many of said baguios did not originate in the China Sea, but proceeded from the Pacific and crossed the archipelago by way of the Visaya Islands or of Mindanao, previous to following the trajectories traced by the director of the Hong Kong Observatory.

With regard to the probable limits of the zone of formation of typhoons originating in the China Sea, Father Algué says:[12]

The number of these baguios or cyclones is relatively insignificant when compared to the many which are formed in the Pacific, and therefore we will briefly say of them that the zone of their formation may be limited by the 5th and 20th parallels and the 112th and 120th meridians, east of Greenwich. It is to be noted, nevertheless, that those formed between the 5th and 14th parallels are few in number, and the great majority of them are formed between parallels 14 and 20 to the west or northwest of Luzon and almost always at a distance from Manila greater than 120 miles.

The average latitude of origin of 25 typhoons observed during the years 1904 to 1915 is 17° 45′ N. Only one storm was formed north of lat. 20° N. and one south of lat. 15° N., while none originated below lat. 14° N.

In Table 8 the average latitude and longitude have been computed for the different types of typhoons. It is interesting to note that the typhoons of north China (type 1a), Japan (2a), Korea (2b), the Philippines (types 4b and 4c), and the Pacific (5a), those formed in the China Sea being excepted, originate mostly east of lat. 140° E., while the typhoons of south China (1b), those of Indo-China which have crossed the Philippines (3b, 3c), those of the Philippines which recurve in the China Sea (4c), and those of the Loochoo group (5b), originate nearer the archipelago. The average latitude of origin of storms formed in the China Sea is 4° higher than the general average, while the storms that go to the Philippine Archipelago proceed from a latitude 3° lower than the general average.

Whenever the origin and the vertex of a typhoon are known, the direction of the first branch of its parabolic path can generally be determined by the laws of spherical trigonometry. The following scheme, which is used to determine the direction of typhoons of the different months before they recurve is mainly of theoretical interest, as storms do not always maintain the same direction when traveling from the origin to the vertex of the recurve. Supposing *a b c* (fig. 1) is the path of a typhoon, originating at *a* (lat. ϕ, long. λ), and recurving at *b* (lat. ϕ', long. λ'). The angle α between the parallel of latitude *ad* and the rhumb line *ab* on the globe will be defined as the bearing of the vertex *b* from the origin *a*. Now, on the Mercator projection, meridians and parallels of latitude as well as rhumb lines all become straight lines. Hence the triangle *abd* is a rectilinear right triangle on the plane of the chart. Moreover the angle which a straight line joining any two places on the chart makes with the meridians or the parallels is equal to that which the rhumb line joining the same two places on the globe makes with the meridians or the parallels.[13]

Angle α as computed from the chart is equal to the angle between the small circle *ad* and the rhumb line *ab* on the globe, or the bearing of the vertex *b* from the origin *a*.

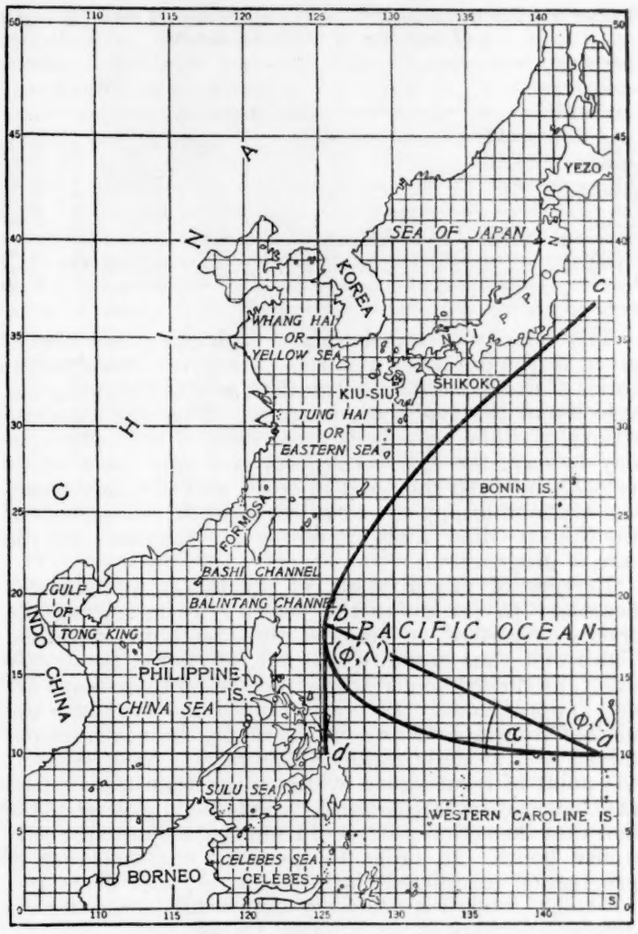

FIG. 1.—Example of the computed trajectory of a typhoon having a given point of origin

Thus[14] $\tan \alpha = \frac{A}{B}$

Where $A = \text{Log. } \tan\left(\frac{\phi'}{2}+\frac{\pi}{4}\right) - \text{log. } \tan\left(\frac{\phi}{2}+\frac{\pi}{4}\right)$

or if we take the length of 1 equatorial degree on Mercator chart as unity,

$$A = \frac{\text{Log. } \tan\left(\frac{\phi'}{2}+\frac{\pi}{4}\right) - \text{log. } \tan\left(\frac{\phi}{2}+\frac{\pi}{4}\right)}{\text{Log. } \tan\left(\frac{1}{2}+\frac{\pi}{4}\right)}$$

and $B = (\lambda' - \lambda)$ in the same unit.[15]

[Attention should be called to the fact that the Naperian logarithms are here used.—ED.]

[11] Algué, Cyclones of the Far East, p. 24, footnote 1. See also S. S. Visher, *loc. cit.*, p. 587.
[12] *Ibid.*
[13] John Riddle, "A Treatise on Navigation and Nautical Astronomy," 9th ed. London, 1871, p. 10.
[14] W. F. Osgood, "Differential and Integral Calculus." New York, 1917, p. 332. Also A. R. Hinks, "Map Projection." Cambridge, 1921, p. 104.
[15] Assuming the earth as a perfect sphere.

The following table is computed by this formula. The last column in the table indicates that the bearing of the vertex from the origin of a typhoon in the months of July, August, and September is northwest, while in the months of May, June, and October it inclines to a more northerly direction, and in the month of December it inclines to a more westerly direction.

TABLE 9.—*The direction of the vertex of the recurve from the origin of typhoons of different months*

	A	B	Tan a	a
				° ′
March	9.15	7.50	1.22	50 40
April				
May	5.02	2.67	1.88	62 00
June	9.27	4.50	2.06	64 10
July	14.00	12.10	1.16	49 15
August	10.45	9.50	1.10	47 45
September	10.22	8.76	1.17	49 30
October	13.86	7.16	1.93	62 40
November	10.18	10.50	.97	44 10
December	8.00	14.00	.57	29 40

The velocity of translation of typhoons is not always given in the published reports. Moreover, the observatories of the Far East differ in their way of indicating the velocity of the typhoon's progress. Thus the Japanese reports give the velocity of progression of typhoons from day to day; the Zikawei reports give only the average velocity between the point of origin and the place where the typhoon disappears or is lost sight of; the reports of the Manila Observatory do not even always mention the rate of progression.

In view of this diversity of practice it was thought necessary to determine the velocity by measuring the tracks as plotted on maps of the Mercator projection. The result thus obtained can not, of course, be strictly exact, as the typhoons' tracks plotted on these maps are only approximately accurate. Since the typhoons are plotted from day to day on the maps, the velocities obtained are the daily means. The rate of progression at the point of recurvature, which is less than the average rate, can not be satisfactorily ascertained, because of the fact that the actual process of recurving may occupy only a few hours. In order to ascertain the velocities of progression in different latitudes, e. g., lats. 0° to 10°, 10° to 20°, etc., it is necessary to measure separately the different portions of the typhoon tracks.

The length of degrees of both latitudes and longitudes in maps on the Mercator projection is distorted, the distortion being greater the higher the latitude. A correction must therefore be applied to the distances as measured along the typhoon tracks.[16] The length of a longitudinal degree on a globe decreases as the cosine of the latitude, being greatest on the Equator and vanishing at the poles, while on a Mercator chart the length of a degree of longitude remains the same from the Equator to pole. On a globe the length of a latitude degree varies but little from latitude to latitude, but on a Mercator chart the distance of any parallel from the Equator is equal to $\left(\frac{d\phi}{\cos\phi}\right.$ or $\left.\log\tan\frac{\phi}{2}+\frac{\pi}{4}\right)$. As shown in Table 10 a degree of latitude calculated according to this formula increases very rapidly with latitude until at the pole it is infinity.

The amount of correction for distances measured along the typhoon tracks on a Mercator chart is calculated according to the data furnished by Table 10, following. It is found to be approximately 30 per cent for tracks that lie between latitudes 40° to 50°, 18 per cent for lats. 30° to 40°, and 9 per cent for lats. 20° to 30°. There is practically no correction for lats. 0° to 20°. The correction is negative, as the distortion is positive both longitudinally and latitudinally, and the amount of distortion in the two directions is the same.

The "average velocity" given at the bottom of the table is the mean velocity of the different months of the year, and not the mean velocity of all the typhoons which have been studied. The average thus obtained is higher than the arithmetical mean because it gives equal weight to the velocities of both winter and summer. It should be remembered that many more typhoons occur in summer than in winter and also that the velocity is higher in winter than in summer.

TABLE 10.—*Corrections to be applied to the velocity measured on Mercator's charts*

Latitude	Relative length of 10 degrees of latitude	Distance on the map divided by Calculated distance	Average correction
	Units		*Per cent*
0°–10°	175	1.0050	0.0
10°–20°	181	1.0368	3.6
20°–30°	193	1.1054	9.0
30°–40°	214	1.2239	18.4
40°–50°	248	1.4197	30.0
50°–60°	306	1.7550	43.0

TABLE 11.—*Velocity of progression of typhoons*

Latitude	5°–10°		10°–20°		20°–30°		30°–40°		40°–50°	
Month	Km. per hour	Nautical miles per hour	Km. per hour	Nautical miles per hour	Km. per hour	Nautical miles per hour	Km. per hour	Nautical miles per hour	Km. per hour	Nautical miles per hour
January	23	12	22	12	50	27	51	27	------	------
February					51	27				
March	20	11	16	9	34	18	37	20	------	------
April	16	9	21	11						
May	14	8	19	10	35	19	37	20	------	------
June			23	12	25	13	43	23		
July	17	9	19	10	19	10	28	15	44	24
August			17	9	16	9	27	15	42	22
September	18	10	21	11	19	10	33	12	42	22
October	22	12	21	11	23	12	36	20	------	------
November	26	14	22	12	25	13	54	29	------	------
December	24	13	25	14	42	23			------	------
Mean	20	10.8	20.2	10.9	30.8	16.7	38.3	20.7	42	23.3

From Table 11 it is clear that the rate of progression of typhoons increases from low to high latitudes and from summer to winter. The variation in velocity with the season is particularly noticeable in that portion of the typhoon tracks which lies between lats. 20° to 30° for the reason that more typhoons recurve north of latitude 20° N. in the summer than in the winter months, and this helps to increase the difference in velocity between winter and summer. On the other hand, for that portion of the typhoon tracks that lies between lats. 10° to 20° the seasonal variation in velocity is small, owing to the fact that many typhoons recurve in these latitudes during the winter, and hence travel at a retarded velocity, while in summer they generally recurve in higher latitudes.

In connection with the velocity of progression of typhoons, Father Algué says:

> A typhoon is said to travel rapidly in the Philippines if its velocity exceeds 12 nautical miles an hour; it moves with a regular velocity when traveling from 6 to 12 miles an hour; its progress is slow if its onward movement amounts to less than this rate. Of typhoons which have been studied up to date, 180 have crossed the archipelago or the adjoining regions of the ocean with regular velocity, 40 with rapid, and 30 with small speed, while a few remained stationary for several days.[17]

[16] W. F. Osgood, "Differential and Integral Calculus." New York, 1917, p. 332. The distance can also be calculated from C. H. Deetz and O. S. Adams' "Elements of Map Projection." Washington, D. C., 1921, pp. 117–136, Mercator protection table.

[17] Algué; "Cyclones of the Far East," p. 92.

The Philippines and the adjoining regions of the ocean may be said to cover lats. 5° to 20°. The average hourly velocity for these latitudes according to Table 11 is approximately 11 nautical miles, which is well within the limit set by Father Algué.

Doberck gives the following average velocities of typhoons: [18]

Latitude	11°	13°	15°	20°	25°	30°	30.5°	Extremes
Velocity m. p. h	5	6.5	8	9	11	14	17	6-36
Kilometers	9	12	15	17	20	26	31.5	11-67

The velocities as given by Doberck are about 4 miles per hour lower than those given in Table 11 for the same latitudes. The Zikawei Observatory at Shanghai has recently issued a pamphelet entitled "Code de Signaux, 1918," in which there is a tabulation of the mean and extreme velocities of typhoons at different latitudes before and after recurvature. The following data are abstracted from that pamphlet.[19]

Average velocity of typhoons in nautical miles per hour

Latitudes	5-15	15-20	20-25	25-30	30-35	35-40	40-50
Before recurvature	9	10	11	11	------	------	------
After recurvature	------	10	17	18	20	21	21

For the sake of comparison, the results obtained in the present investigation are here again tabulated:

Latitudes	5-10	10-20	20-30	30-40	40-50
Mean velocity, m. p. h	10.8	10.9	16.7	20.7	23.3

The average velocities as given in the above two tables agree remarkably well. It appears therefore that the velocity of typhoons as given by Doberck is too low. Further, Doberck gave the velocity at lat. 30° N. as 14 miles an hour, and 30.5° N. as 17 miles an hour. It hardly seems as if a difference of half a degree of latitude could make as much difference as 3 nautical miles an hour in the average velocity.

[18] Doberck; "The Law of Storms in the Eastern Sea," 1898, p. 16; see also Hann, "Lehrbuch der Meteorologie," 1915, p. 607.

[19] "Code de Signaux, 1918." Extrait du Calendrier-annuaire pour, 1918. Zikawei, près de Changhai, 1917, p. 15-16. Compare also Louis Froc, "Atlas of the Tracks of 620 Typhoons, 1893-1918," Tables Nos. 1 and 2.

CONCLUSIONS

One of the most important problems connected with typhoons is the immediate cause of these remarkable phenomena. In order to solve this problem, it is necessary to have a network of weather stations in the regions of the west Caroline and the Ladrone Islands, to have complete and accurate observations of the surface pressure and wind conditions, and also to secure meteorological records from the upper air 5 or 10 kilometers above the surface. Without such data any theory that may be advanced in explanation of the origin of typhoons necessarily rests upon rather insecure foundations. What at present can be done is to organize the material which has already been obtained by the various meteorological observatories in the Far East, and thus to throw some light upon the question. A clear and well-defined classification of typhoons is a step in that direction, for the various types of typhoons not only come in different seasons and visit different regions, but also differ in their point of origin. Besides giving a new classification, the present discussion has brought out three points which need emphasis.

In the first place, the word "typhoon" has been given a definite meaning. While hitherto "typhoon" has been used to denote almost all the tropical storms which have been observed in the Far East, and in a few cases even to include extratropical cyclones, the term has been defined to mean a well-developed tropical storm in the Far East in which a wind velocity of Beaufort scale 6 or more has been observed. Standardization of the term is necessary in order to make the reports of different observatories on typhoons strictly comparable.

Secondly, in the past the storm tracks have been studied by plotting the mean tracks. These mean tracks are ususally too much generalized and give very little idea as to the limits of the area frequented by the storms and their relative frequency in the different regions. In the present paper the typhoon tracks are studied by means of charts of composite tracks of the different months. Thus the storm tracks of a certain month in a given period are presented graphically as a whole.

Certain new facts connected with the pressure, temperature, and wind conditions in the center of typhoons, reported during the 12 years from 1904 to 1915, have been collected and given by the writer in a condensed form [20] in a previous paper.

[20] Chu, Co-Ching, Some New Facts about the Centers of Typhoons. MO. WEATHER REV., September 1918, 46: 417-419.

PRESSURE OVER THE NORTHEASTERN PACIFIC, AND WEATHER IN THE UNITED STATES, DECEMBER, 1924, AND JANUARY, 1925

By ALFRED J. HENRY

SYNOPSIS

This paper is an attempt to show the relation between the pressure distribution over the North Pacific Ocean, east of about the 180th meridian of west longitude, and the weather of the United States for corresponding periods.

The pressure charts used were those for the Northern Hemisphere prepared twice daily in the Forecast Division of the central office of the Weather Bureau.

It is fully realized that useful precepts for forecasting weather some days in advance, or other form of generalization can not safely be drawn from the record of a single month or so; nevertheless the most important tendencies may be pointed out. These are:

(1) A barometric minimum over the Gulf of Alaska or the Aleutians with fully developed cyclonic wind circulation does not readily pass inland as such, but rather oscillates back and forth with at times increasing and at times decreasing pressure at its center, until the conditions are favorable for (*a*) the passage of the cyclone in its entirety inland, evidently a very rare occurrence, or (*b*) the entrance of a mass of warm and moist air from it over the continent which later may or may not form a cyclone.

(2) The Aleutian or Northeast Pacific LOW must be considered as the origin of the great majority of low-pressure systems (cyclones) that pass from west to east across the Rocky Mountains. While at times it is difficult to trace the LOWS in a continuous path back to the Pacific, it seems reasonably certain that the original impulse that created them came from the Pacific.

(3) The most interesting and important place for study is the point of first contact of oceanic cyclones with the shore line of the continent where pronounced discontinuities in both temperature and moisture must be found.

THE NORMAL PRESSURE DISTRIBUTION OVER THE NORTH PACIFIC

The average pressure distribution over the North Pacific Ocean is characterized by two very pronounced formations, one of average low pressure, the other of average high pressure, often referred to in the nomenclature of Tiesserenc de Bort as "centers of action" of the atmosphere but commonly known as the Aleutian LOW and the North Pacific HIGH, respectively. In order that a clear understanding of both of these may be had the following details, most of which are already well known, are given:

The Aleutian Low.—A meteorological station has been maintained intermittently on Unalaska Island, one of the three larger islands of the Aleutian group, for a number of years. The station was originally known as Unalaska, but is better known at present as Dutch Harbor, the site of a small settlement and a high-power radio station maintained by the United States Navy.

The fact that atmospheric pressure was nearly always low in the cold season at this station was clearly shown by Signal Service observations of a quarter of a century ago; hence the descriptive term Aleutian LOW has come into rather general use. It should be remembered, however, that the center of low pressure in that part of the globe may at times be a thousand miles distant from the Aleutian group.

Neither the so-called Aleutian LOW or the North Pacific HIGH should be thought of as definite entities which preserve at all times the form and position as portrayed in textbooks and meteorological atlases. Both formations are subject to the seasonal and accidental pressure changes common to the latitude in which they are found. During periods of time ranging from 3 to 10 days the pressure in the regions normally occupied by these two formations may be completely reversed. [See fig. 2, December 16, (a. m.).] Such reversals are, however, of infrequent occurrence.

The Aleutian LOW as portrayed in Weather Bureau Bulletin A appears as a long, narrow region of low pressure that stretches nearly 3,000 miles almost due west from a point on the Alaskan coast at about 55° north latitude. Average pressure in or near the center of this area is lowest—29.58 inches—in December. From that minimum it increases very slowly in the remaining winter months, more rapidly in spring, until in July it has risen to about 30 inches. At this time the center of lowest pressure appears to be in much higher latitudes.

The North Pacific High.—According to Bartholomew's Atlas the January position of this HIGH is near the intersection of the parallel of 30° North latitude and the meridian of 140° West longitude. As the season advances the center of this HIGH is found farther and farther to the west and northwest of its January position, so that in August it is located approximately at 36° north, 150° west. With the approach of the cold season it begins a retrograde movement toward the continent. Pressure at the center of this HIGH averages 30.10 inches in October and rises from that level to 30.30 inches in April, continuing at that level until October. Analogous pressure formations are also found in the eastern North Atlantic Ocean.

THE PERIOD DECEMBER 1–9 OVER THE NORTH PACIFIC

The dominant pressure control during the above-named period was an extensive area of low pressure centered over the Northeastern Pacific as indicated in the table below.

Dutch Harbor, whose geographical coordinates are 53° 55′ N. lat., 166° 30′ W. long., may be considered as a point of reference for determining the fluctuations in the position of the center of the North Pacific LOW in the table.

Approximate position of Aleutian Low,[1] December 1–9, 1924

Date	West longitude	North latitude	Pressure
			Inches
Dec. 1	147	52	29.20
Dec. 2	154	49	29.20
Dec. 3	147	52	29.00?
Dec. 4	157	52	29.50?
Dec. 5	[2] 175	45	29.50
Dec. 6	174	46	29.10?
Dec. 7	157	52	29.10?
Dec. 8	150	56	28.64
Dec. 9	150	45	28.50

[1] Considerable uncertainty exists as to the exact location of the center of the LOW on many of the dates.
[2] East longitude.

The shifting in latitude and longitude as shown in the above table is, in part, more apparent than real, due to the lack of radio reports on successive days for approximately the same part of the ocean. Unless the number of radio reports is greatly increased it will be generally impracticable to locate the center of a barometric depression with an accuracy of less than about 500 miles.

On December 4 there is clear evidence of a new cyclone approaching from the west; two days later this new cyclone has lost its individuality by merging with the general depression in the vicinity of the Aleutians. Four days later the center of the combined depression passed Kodiak Island but evidence still persisted of cyclonic activity in approximately N. lat. 35°, W. long. 163°. The foregoing illustrates the fact elsewhere stated by the writer that the Aleutian group of islands is merely a port of call for North Pacific cyclones and that it is difficult by reason of lack of sufficient observations to distinguish between the several cyclones which touch at and pass Dutch Harbor.

Three days later, December 11 [see fig. 1, December 11 (a. m.), and fig. 2, December 16 (a. m.], pressure over the western Aleutians and for a great part of the Northeast Pacific had risen above 30 inches and the end of the LOW that we have been considering was in sight.

Rising pressure in this case seemed to come from the northeast, or the interior of northern Alaska.

Attention is now directed to a consideration of the relations that appear to subsist between the pressure distribution that has just been described and the weather in the United States. On December 1 (see daily weather map of that date)[1] the outer isobar of the oceanic LOW, that of 29.90 inches, had penetrated northwest Washington and British Columbia. The temperature in that region had risen and precipitation had set in, indications that the influence of an oceanic LOW was being felt.

Figure 1—December 1, 8 p. m.—shows the pressure distribution at the evening observation of that date; note the isobars curving inland over the Washington and Oregon coast and thence northward. The conditions for the formation of a vigorous LOW at the surface at this time were not good. Radio reports from the Pacific on the p. m. of the 1st showed the presence of a vigorous anticyclone off the California coast, and the land observations on the morning of the 2d showed that this anticyclone, attended by lower temperature and rising pressure—two conditions inimical to cyclonic development—was passing inland over this Oregon coast.

[1] Frequent reference will be made to the daily weather maps throughout this paper. The Washington printed map, Form C, is meant in all cases.

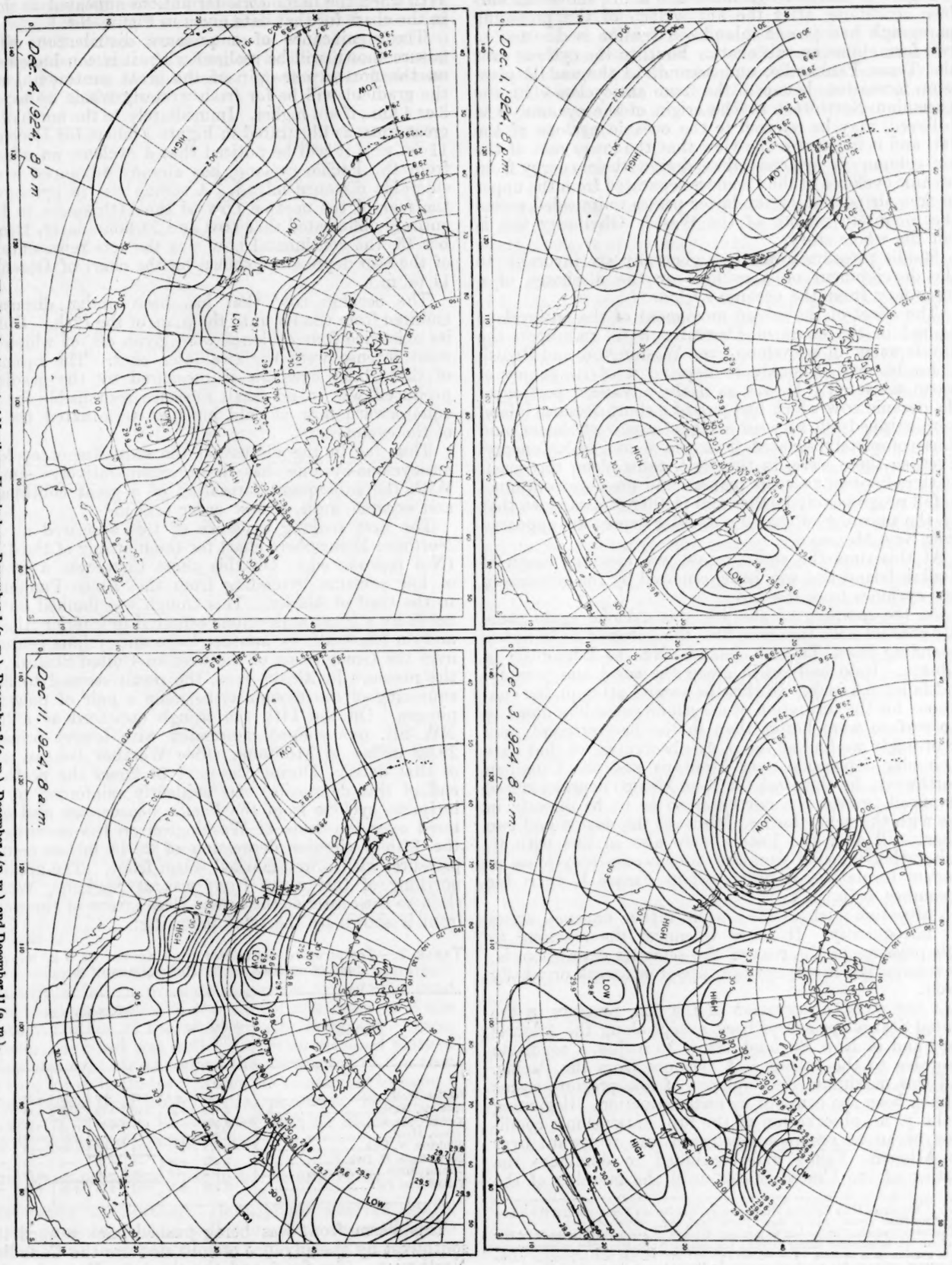

FIG. 1.—Weather charts, part of Northern Hemisphere, December 1 (a. m.), December 3 (a. m.), December 4 (p. m.), and December 11 (a. m.).

Figure 1, chart of December 3, 8 a. m., shows the surface conditions after the anticyclone of the preceding paragraph had passed inland. Attention is directed to two formations on this chart: First, to the cyclone over the Texas Panhandle, and second, to the saddle pressure formation between the two anticyclones in the Canadian Northwest. The origin of the cyclone, it is believed, may be referred to the oceanic cyclone of the 1st, and it illustrates the view that the lower part of the air column in cyclones that derive their energy from oceanic cyclones of the Pacific is separated from the upper or free air portion as the latter passes unimpeded across the mountain regions of the West.[2] Obviously this is not the whole story.

Saddle pressure formations generally are favorable to the development of a cyclone or the discharge of a secondary from the oceanic cyclone.

The effect of the inland movement of the anticyclone figured in the chart of December 3 (a. m.) upon the development of a cyclone over Washington and British Columbia was suddenly to deprive it of its supply of warm moist air. It was as if the advanced portion of the oceanic LOW which had passed a short distance inland were snipped off, as with a gigantic pair of shears, and thus completely isolated from the source of its energy. Even so there were, in this case, rains along the coast, scattered snows over the plateau and pressure continued to fall progressively farther and farther eastward, so that by the morning of the 3d a circular depression appeared over New Mexico.

At this time the oceanic LOW was centered south of Kodiak Island and was being renewed by the advance of new cyclones from the west.

On the morning of the 4th this cyclone again came into contact with the shore line, the isobar of 29.70 inches extending from Tatoosh Island NE. to Edmonton in Alberta. Rain had set in along the coast and pressure had fallen 0.3 inch. In this the second attempt the conditions for the formation of a cyclone extending down to the surface were better than in the first attempt, and accordingly we find at the p. m. observation of that date a circular depression over Montana and the Canadian Northwest; by this time the New Mexico depression had advanced toward the northeast so as to be directly in line with the newly formed Montana depression and two others still over the Pacific were also in line with it. This rather unusual situation, four separate cyclones in tandem formation, is portrayed in Figure 1, chart for December 4 (p. m.).

A situation such as this, while rather unusual, arises not infrequently. It arises whenever the reaction[3] to high pressure in the rear of the separate depressions is, for reasons which are not now apparent, weak or wholly absent.

At the p. m. observation of the 5th, pressure in the United States was everywhere, except along the Atlantic coast and in New England, below 30 inches, a condition favorable to the entrance of cyclones from the Pacific. And this maximum development of low pressure seems to have been the cause of its own extinction. Beginning at the p. m. observation of the 6th, anticyclonic conditions began to progress southward and westward over the Missouri Valley and continued to dominate the weather of the United States until the morning of the 11th when the barometric formations appeared as shown in the chart for that date given in Figure No. 1.

The significance of a pressure distribution of the nature shown will be realized when it is considered that on the northern margin of the great continental HIGH the gradient will be for fresh westerly winds up to, say, 3 or 4 km., if not higher. Immediately to the north of the great HIGH as illustrated in Figure 1 [chart for December 11 (a. m.)] it will be noticed that a cyclone, an offshoot from the Pacific cyclone, has already advanced a considerable distance inland. A strong rise in pressure in the rear of the oceanic LOW of the 11th seems to have entirely obliterated that LOW and 24 hours later, December 13, the continental LOW was the sole representative of the two depressions shown on the chart of December 11 (a. m.).

The oceanic LOW that has been under discussion endured from the 1st until the p. m. of the 12th. During its existence four cyclones were given off, of which the most intense were the two later ones. The intensity of these later cyclones as measured by the gradients produced was in no small measure responsible for the equatorward flow of cold air that terminated the life of the cyclones.

Thus far in the discussion the sequence of cyclone-anticyclone-cyclone has been comparatively simple. With the subsequent formation of a great continental and oceanic HIGH, a new order sets in.

The first striking evidence of this appeared on the Northern Hemisphere chart for the morning of the 13th. (Not reproduced.) On this chart there was a trough of low pressure extending from the Texas Panhandle to the Gulf of Alaska. This trough was flanked on the north by a great anticyclone centered in interior Alaska, and on the south by another large anticyclone centered over the Great Basin of the western United States. As the pressure in Alaska rose, the result seemed to be a squeezing of the trough as between a pair of powerful pincers. On the 14th the trough appeared as a long NW.-SE. oval-shaped depression with lowest pressure 29.60 inches in Montana. (See Weather Bureau map of that date.) During the next 24 hours the northern end of this depression was evidently reinforced by an incipient cyclone from the Pacific because we find centered over the State of Washington on the morning of the 15th a circular depression of 29.45 inches central pressure, with a well-marked warm front. The greatest northing of this warm front was at Spokane, Wash., close to the center of the LOW. The extent of the warm front is shown by the table following:

TABLE 1.—*Temperature departures from normal at 8 a. m., 75th meridian time, at the stations named*

Stations	Elevation	December, 1924					
		12	13	14	15	16	17
	Feet						
Seattle, Wash.	125	+9	+12	+9	−17	−25	−30
Spokane, Wash.	1,929	+20	+20	+18	+16	−30	−30
Kalispel, Mont.	2,973	+23	+27	+21	−13	−32	−33
Havre, Mont.	2,505	+33	+11	+5	−33	−43	−41
Williston, N. Dak.	1,872	+34	+14	+6	−10	−32	−32
Devils Lake, N. Dak.	1,482	+24	−6	−10	−4	−32	−32
Duluth, Minn.	1,133	+8	−16	−26	−6	−22	−28
Yellowstone Park	6,200	+12	+12	+16	+16	−38	−46

This warm front was being pushed back toward the southwest by the advance of cold air from the Canadian Northwest. (See fig. 2 and the chart for December 16,

[2] Cf. T. Kobayasi, On a Cyclone Which Crossed the Corean Peninsula and the Variations of Its Polar Front. Quart. Jour. Royal Met. Soc., 48:169-183.

[3] The term "reaction" is used in its mechanical sense, as exemplified in the third law of motion. If, for example, falling pressure be considered negative, then rising pressure may be considered as positive. The "down and up" movements in the pressure curve are, however, only roughly equal and oppositely directed, as in the mechanical sense.

which shows the LOW in a position almost due south of that which it had 24 hours previously.) On the morning of the 16th surface temperature in Montana, northern Idaho, and northeast Washington had sunk to zero and below. Pressure at the center of the LOW had now dropped to 29.26 inches.

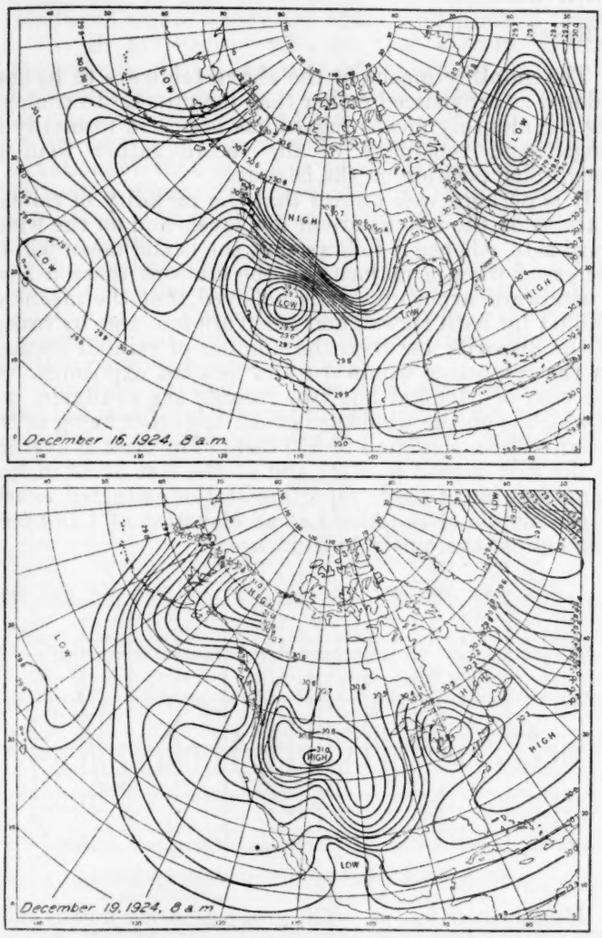

FIG. 2.—Weather charts, part of Northern Hemisphere, December 16 and 19 (a. m.). Isotherms are not drawn over water areas and have been omitted from the land in the interest of simplicity. The range in temperature on the chart for December 16 between the HIGH over western Canada and the LOW over the Great Basin in the United States was 85° F. or from −40° to 45° F. The winds in the region where the isobars are so greatly crowded were light northerly, force 2. In the northeast quadrant of the LOW moderate to fresh southerly winds prevailed. The indicated barometric gradient is largely due to the surface temperatures used in the sea-level reduction and is to that extent artificial.

The reason for this fall in pressure is not apparent; ordinarily a fall in pressure might be expected, if and when the temperature of the air column rises, or if the gyratory motion of the whirl greatly increases. Since, however, the whirl was centered over an elevated plateau in dry and cold air and since the movement of the LOW was into lower latitudes it would be reasonable to expect higher, rather than lower, central pressure. Eventually the central pressure in this LOW rose to 30.05 inches. (See fig. 2, chart of December 19.)

THE HIGH PRESSURE PERIOD DECEMBER 19-21, 1924

Reference to Northern Hemisphere weather charts for the dates mentioned will show that unusually high pressure was experienced west of the Mississippi, a maximum of 31.22 inches being recorded at Lander, Wyo., on the 20th.[4]

This period of high pressure in the United States and the Candian Northwest endured practically until the end of the month, diminishing somewhat, however, on the California coast on the 22d and again on the coast of British Columbia and the State of Washington during the 27th to 31st.

PRESSURE CONTRASTS DURING JANUARY, 1925

Since writing the foregoing advantage has been taken of the opportunity to examine the Northern Hemisphere weather charts of January, 1925.

I have scaled from the daily charts of both December, 1924, and January, 1925, the pressure at the intersection of N. lat. 35° and W. long. 140°, the geographical coordinates of the approximate center of the North Pacific HIGH for these months. The monthly means computed from the scaled values are for December 30.14 inches and for January 30.23 inches, therefore, broadly speaking, pressure in this HIGH was somewhat below normal in December and above in January.

The average daily values for the first and second halves of January were 30.41 inches for the first half and but 30.08 for the last half, showing that there was a decided diminution of pressure in the last half as compared with the first. I also computed the daily mean pressures for Dutch Harbor in the Aleutians and Eagle, in interior Alaska, for the corresponding periods. Both of these stations experienced higher pressure in the second than in the first half, the excess being 0.41 inch for Dutch Harbor and 0.52 inch for Eagle, or the reverse of the pressure distribution in the North Pacific HIGH. It has been tacitly assumed that the same sort of reciprocal relation exists between the pressures in the North Pacific HIGH and the Aleutian LOW that are known to exist between the Azores HIGH and the Iceland LOW of the eastern North Atlantic.

The facts as above confirm this impression. That there may be no misunderstanding these facts are restated as follows: (1) The North Pacific HIGH during the first half of January, 1925, was fully developed and in approximately its normal position; (2) pressure in Alaska was low relative to that in the North Pacific HIGH in the first half of the month and higher in the interior during the second half, the reverse of the conditions which existed during the first half.

What then is the significance of the change that took place in pressure distribution in the second half of January, 1925?

The answer, whatever it may be, should contain a reservation that only a provisional one is possible at this time.

High pressure in interior Alaska must furnish the mechanical energy necessary to drive polar air far to the southward, provided there are no unsurmountable obstacles in the way. The earth's surface does not provide obstacles of moment, but the atmosphere itself may determine both the direction and the strength of the equatorward flow.

Examining the daily weather maps of the United States Weather Bureau for both halves of January, assuming of course that the last half, though it contains 16 days, is practically equal to the first half of but 15

[4] Probably at least a tenth of an inch too high due to the very low temperature, locally at the station, when the observation was made.

days, I have not been able to find any very striking differences between the weather of the two halves of the month.

There was greater cyclonic activity during the second half than in the first, the weather was more changeable, and there was a pronounced southward and eastward flow of polar air on the 26th–28th. On the whole, the differences were not important. The temperature and precipitation were both rather close to the normal, so close that we feel justified in characterizing it as an average winter month.

HAWAIIAN RAINFALL

By ALFRED J. HENRY

The recent publication by the Weather Bureau of statistics of rainfall and other climatic data for Hawaii[1] puts in convenient form for study the individual monthly amounts of rainfall as recorded for each month of the year at 59 stations in Kaui, 120 in Hawaii, 72 in Maui, and 77 in Oahu, 2 in Lanai, and 5 in Molokai, a total of 335 records, but not necessarily for that number of individual stations, there being in a number of cases several records of observation for one and the same place. An attempt has not been made to consolidate the several series just mentioned into a single consecutive series.

The object of this paper is to draw attention to the statistical data thus made available and to very briefly touch upon some of the best-known characteristics of Hawaiian rainfall.

The outstanding feature of the rainfall distribution in Hawaii is the very wide variation from one place to another separated from each other by only a few miles, also by the wide variation in the amounts for the same months in different years.

As much as 31.95 inches of rain have been registered as falling on a single day and 102.46 inches in a single month of 31 days, or an average of 3.30 inches on each day of the month. The annual amounts range from a maximum of 562.00 to a minimum of 2.46 inches on the island of Maui.

Mean monthly and annual rainfall, by islands.—Table 1 below gives the monthly and annual means for each of the four large islands of Hawaii, Kaui, Oahu, and Maui. The monthly means were computed from the records of 10 years or more in length on each of the several islands and were taken from the regular monthly publication Climatological Data, Hawaiian Section, 1923, by Thomas A. Blair.

The small number of stations on both Lanai and Molokai and their geographic distribution make it inadvisable to attempt to compile a mean for those islands.

TABLE 1.—*Average monthly precipitation, Hawaiian group, by islands*

Stations	January	February	March	April	May	June	July	August	September	October	November	December	Annual
Hawaii	9.15	8.65	10.58	**11.03**	8.26	5.87	8.18	10.11	7.42	6.25	10.90	10.29	106.69
Kaui	5.84	4.60	7.66	4.27	3.94	3.40	5.60	6.11	6.39	5.98	8.25	**8.29**	70.33
Maui	5.81	7.51	8.65	10.20	7.35	5.82	7.67	9.85	6.84	*5.42*	10.37	**11.20**	96.69
Oahu	6.01	5.97	6.31	5.59	4.12	3.44	3.48	4.05	4.65	3.93	6.32	**7.87**	61.74
Group mean	6.70	6.68	8.30	7.77	5.92	4.63	6.23	7.53	6.32	5.39	8.96	9.41	83.84
Adjusted 30-day mean	6.50	7.01	8.05	7.77	5.74	4.63	6.04	7.30	6.32	5.23	8.96	9.13	------

[1] Summary of the Climatological Data for the United States, by Sections, Washington, 1922. In Figure 3 of this publication, the block with the title "Oahu (Mountains) Leeward" needs a word of explanaton in view of the well-known decrease of rainfall on the leeward side of the mountains.

The author of the publication in an unpublished letter indicates that the block as above indicated refers exclusively to that part of the Ko-o-lau Range extending from its crest a few miles to windward. It is recalled that the average altitude of these mountains is not more than 2,000 feet, not high enough to block the passage of the northeast trades. The rain that falls immediately in lee of the crest should be considered in the nature of an oversplash from the rain that falls on the windward side.—EDITOR.

The monthly means of the above table are to be considered as provisional rather than definitive. In computing the monthly means regard has been had primarily to length and reliability of the record rather than to geographic position on the islands.

It is perhaps well known that the majority of rainfall stations on the islands are at low levels and on the windward side, whence it follows that the island mean will be increased when a majority of the stations thereon have a windward exposure. It is believed that the means of Table 1 for both Hawaii and Maui are too large by reason of the disparity between the number of rainfall stations on the respective windward and leeward exposures. In the case of Molokai but two records are available, one of which is on the windward coast, the other being in the interior at an elevation of 800 feet. The annual average at the first named is 67.03 and at the last 34.82 inches. Lanai has but a single reporting station, situated nearly in the middle of the island at an elevation of 1,780 feet. The annual average is 35.70 inches.

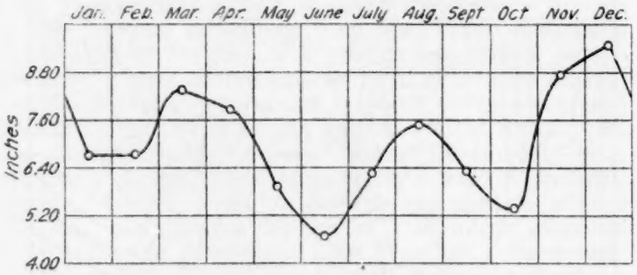

FIG. 1.—Composite curve of monthly rainfall distribution

Monthly distribution.—The group monthly means show three rather distinct maxima, one each in March, August, and December and three minima, one each in February, June, and October. Figure 1 presents these facts graphically. The chief maximum occurs in December and the chief minimum in October. These are most likely the more stable of the phenomena of monthly distribution. The August maximum is largely dependent upon the intensity and position of the North Pacific area of high pressure, which usually is centered about north latitude 40° and west longitude 145°; the spring maximum, which on Hawaii is deferred until April, is probably in some way related to the increased wind movement of that season coupled with the frequency of occurrence of southerly storms.

The chief minimum, which on Maui is deferred until October, comes in early summer at a time when cyclonic activity to the northward of the islands is at a low ebb and the pressure gradient for northeast winds is at the lowest point for the year. This minimum is most pronounced on Kaui and Oahu and on the leeward slopes of Maui, Molokai and in a much less degree in the Kau district of Hawaii.

The difference in latitude between the southern tip of Hawaii and the northern coast of Kaui is 3 degrees, a comparatively small distance when temperate latitudes are considered but probably too great to be disregarded in the Tropics. The February minimum is pronounced on the most northerly islands of the group, Kaui and Oaha, and is also in evidence on windward Hawaii, windward Oahu, windward Maui, and leeward Oahu.

Dr. B. M. Varney tells me that a weak secondary February minimum is noticeable in central and southern California rainfall. I have also found a decided minimum for a mountain station in Porto Rico, although the record is for but nine years' observations. The geographic situation of that island is somewhat analogous to the Hawaiian group, viz, in about the same latitude and southwest of a great oceanic area of high pressure, the Azores HIGH.

The autumn minimum in Hawaii comes at a season when the atmospheric processes that cause rain are inactive, and in this respect the conditions in the Hawaiian group are not materially different from those which obtain over continents.

The daily rainfall.—I have computed from the daily rainfall records of Hawaii, 44 stations in all, the average amount of precipitation for each day of January, 1923,

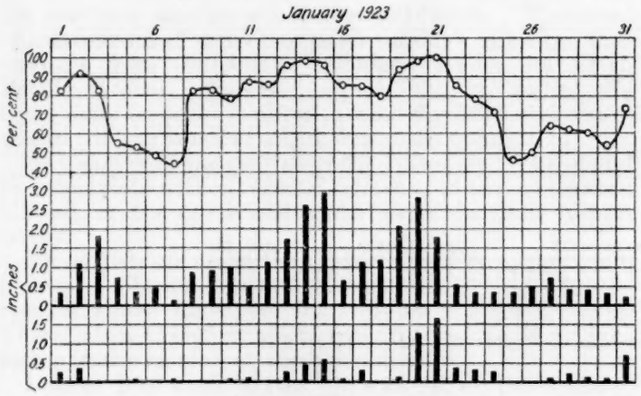

FIG. 2.—Percentage frequently of rainy days and average daily amounts of rain at 44 stations, island of Hawaii, during a wet month, January, 1923

a very wet month in the whole group; also the percentage of frequency. The latter was determined simply by counting the number of stations on which a measureable amount of rain was recorded for each day of the month. These percentages have been plotted to form the irregular line at the top of Figure 2 and the series of vertical bars immediately below represents the average amount of precipitation for each day of the month. The lower set of vertical bars represents the average amount of rain that was recorded at the five stations in the leeward districts of Hawaii—north Kona and south Kona, respectively.

The rainfall of these two districts on the leeward side of Hawaii is essentially different from that of similar sides on the remaining islands, the chief difference being that the maximum amounts for the year come in the months of May, July, and August, as will be shown later. (See fig. 4).

The above diagram shows that considering the island as a whole a measureable amount of rain fell on every day of the month; in the leeward districts, however, this was not the case. The diagram further shows that there were at least three periods of three to five days each with some rain at 90 per cent or more of the stations and that the average amount on these days was several times greater than on the other days. The lower set of bars shows that in leeward districts there were relatively greater rains on the days of high frequency and amounts in all Hawaii.

The causes of rainfall in Hawaii.—In general the primary cause of rainfall in the Hawaiian group is the pressure distribution over the North Pacific that controls the direction and force of the winds. The northeast trades, which some one has said blow "persistently and monotonously" over nearly all parts of the group, are the immediate cause of the rainfall. These winds, as is well known, pass over a very considerable extent of water surface and for the most part must be rather highly charged with water vapor. Meeting the high cliffs and other obstructions that abound on the windward shores of the several islands, they are forced upward, their moisture is condensed by the cold of elevation and falls as rain. Thus the rainfall must be classed as almost wholly orographic.

Average pressure charts and the rainfall of Hawaii.—When considering average pressure charts a mental reservation about as follows should always be made: While average pressure charts are good to look at, they very rarely represent the real conditions which prevail on any single day, month, or year; hence when we speak of the North Pacific HIGH as a distinct entity which has form and movement we, to a certain extent, create a false impression. What we really wish to express is the thought that the pressure over the North Pacific, as elsewhere over the oceans, is constantly changing and never remains at the same level and in precisely the same formation for more than a day or two.

Heavy rains in Hawaii, particularly in the months November to April, are associated with changes both of geographic position and intensity, of this North Pacific area of high pressure or, for short, the North Pacific HIGH.

The average position of this pressure formation in February, according to Bartholomew's Atlas, is close to the intersection of the 140th meridian of west longitude with the 35th parallel of north latitude. This HIGH has a seasonal shift as follows: In the cold season it approaches and at times merges with the continental area of high pressure over the Canadian Northwest. As the warm season advances the center of the HIGH is found farther and farther west and north; thus in August and September, which months mark its greatest development, its center is approximately in west longitude 150° and north latitude 40°; it then begins to recede toward the North American Continent to again begin its annual cycle of movement. The level of the barometer in this HIGH is lowest, 30.10 inches, in October; it increases to 30.20 in November and continues at that level until the end of March, then rises to 30.30 and maintains that level, April to September, both inclusive.

As indicated in the above paragraph, the North Pacific HIGH is not so pronounced in the winter as in the summer; hence it follows that the trade winds of winter are less stable than in summer when the HIGH is best developed; moreover, the frequency and intensity of cyclonic systems that pass eastward along the Aleutians in winter is a second factor which tends to increase and at times reverse the direction of the prevailing winds of the Hawaiian Islands. Owing to the low latitude of the islands, very few, if any, fully developed cyclonic systems pass directly over them, and cyclonic rainfall, as such, rarely occurs. Nevertheless, in the months from November to April, the procession of cyclonic storms or areas of

low pressure is moving across the North Pacific from west to east in the neighborhood of the 52d parallel of north latitude or along the Aleutians. Each of these LOWS is attended by a fall in pressure, which on the average shades off from four-tenths to five-tenths of an inch at its center to, say, one-quarter of that amount in the region occupied by the North Pacific HIGH; thus pressure in the high suffers a reduction whenever a LOW moves east along the northern path. As the pressure is reduced the gradient for northeast winds over Hawaii is also diminished, and when the pressure reduction is great enough that gradient is replaced by one for SE. to S. or even SW. winds, which characterize the so-called "Kona" or southerly storms [2] that are a feature of the cooler season in the islands. Thus it results that those slopes which were leeward slopes during the prevalence of the trades now become windward slopes, and, like the former windward slopes for northeast winds, now receive generous rains.

The occurrence of one or more southerly storms in a single month will increase the rainfall of that month several fold as compared with a dry month. During the years 1905 to 1923, 38 months out of the 228, or 17 per cent, had a rainfall of 10 inches or more. The distribution of these months throughout the year was as follows: Winter, 18; spring, 11; summer, 3; and autumn, 6. June and October had no rainfall of as much as 10 inches. The months of heavy rains were irregularly distributed throughout the period, the first half having but 12 as against 26 in the last half. In the latter there were three consecutive years with rainfall above the average, 1921–1923. The islands have therefore just passed through a time of greater than the average rainfall. Casual inspection of the data does not indicate that any definite cycle in the rainfall is operative. Other studies, however, as indicated in the next paragraph, point to a different conclusion.

Mr. Joel B. Cox in his paper on "Periodic fluctuations of rainfall in Hawaii" [3] postulates the existence of a 3.7-year period and submits the evidence therefor. He also finds evidence that cycles of 11.1 years and 33 years are present in Hawaiian rainfall.

Rising pressure is also an important factor in the rainfall regime of Hawaii. So soon as pressure begins to rise after a fall the winds become northerly and northeasterly, thus temporarily intensifying the NE. trades and increasing the rainfall. The fact that the wind has been southerly for a few days increases the likelihood of heavy falls of rain by reason of the presence over the islands of a mass of warm southerly air of high moisture content.

High pressure at Honolulu is associated with light rainfall and conversely low pressure with heavy rainfall, the explanation being that with high pressure there are few, if any, interruptions to the NE. trades, and conversely low pressure is indicative of frequent interruptions. A normal or weak trade is indicative of moderate rains on windward slopes and little or no rain on leeward slopes.

Notes on Hawaiian rainfall based on the Northern Hemisphere Weather Map.—This map for the last year or so has been prepared from radio reports of meteorological observations made on board ships navigating the Pacific. Together with reports from Honolulu and Midway Island it serves to illuminate the character of the pressure formations that control the weather of the islands, and especially the relation of the pressure distribution to heavy rains on the islands. I invite attention to the two groups of days January 12–15 and 19–21, 1923, as illustrated in Figure 2. The pressure distribution associated with these two groups was in the beginning

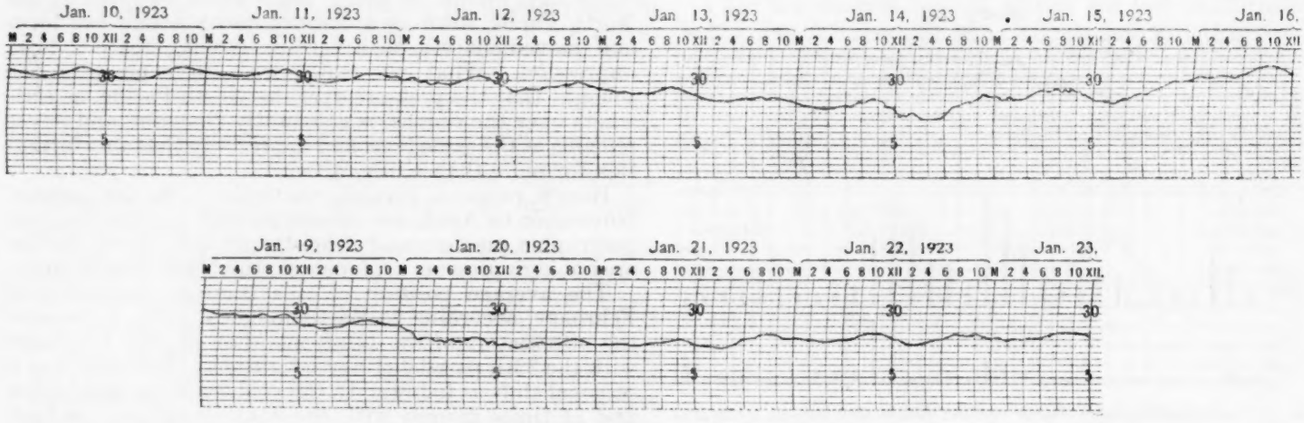

FIG. 3.—Barograph traces at Honolulu, January, 1923

one that gave a gradient for fresh northeast winds. This gradient weakened on the 13th and was considerably intensified on the 14th and 15th with maximum wind velocities at Honolulu of 56 and 55 m. p. h., respectively. This change in gradient was induced by changes in pressure of which the only example available is that for Honolulu. The barograph traces for that station for the periods in question are reproduced in Figure 3 above. Examining these closely it will be seen that the diurnal pressure variation so characteristic of the Tropics is in evidence throughout the period, but that it is considerably disturbed on several days. The 10 a. m. and 10 p. m. diurnal maximum is clearly shown in the traces for the 10th and the 11th, but on the 12th, while the 10 a. m. maximum is plainly shown, the p. m. minimum for that date is perceptibly lower than for the previous day; the immediately following maximum is also a shade lower than it was on the 12th. The fall thus initiated continued slowly and reached its lowest level on the p. m. of the 14th. Compare that minimum with the one of the 12th 48 hours earlier. This change is unlike those which occur in higher latitude on the approach of a barometric disturbance, being much slower in completing the change from high or normal to low and back

[2] Cf. Daingerfield, L. A., Kona Storms. MO. WEATHER REV., 49: 327-329. Blair, Thomas A., Trade Winds of Hawaii. MO. WEATHER REV., 51: 525, 526.
[3] Transactions of American Soc. of C. E. 87:461 (1924).

to its initial level; the amplitude is also much less. The pressure did not again reach the level of 30 inches until 10 p. m. of the 15th; after remaining close to that level for several days it again began to fall on the 19th, and, as in the preceding case, the fall is first apparent in the 10 a. m. maximum of the 19th. The lowest level was reached on the 20th, but the barometer remained low throughout the remainder of the month, with variable winds and moderate rainfall. (See fig. 2, as to rainfall).

The cycle of changes described above is most likely due to a fall in pressure that advances from west to east in synchronism with the west-east movement of extra-tropical cyclones over the path which passes along the Aleutians or close to the parallel of 52° north latitude. It is probable that there is a slight southward seasonal shift in the latitude of North Pacific cyclone paths in the cold season and that on occasions these storms pass nearer to the Hawaiian group of islands than at others. Obviously the magnitude of pressure changes at Honolulu depends largely on the closeness of approach of the extra-tropical cyclones of the North Pacific.

The orientation of the longer axis of the North Pacific HIGH, whether west-east or north-south, is also an important factor in the weather control of the islands. If the longer axis takes a north-south or a northwest-southeast direction, southerly winds over the Hawaiian group and the resulting weather conditions will follow. The speed of movement of traveling areas of high pressure that advance from the Asiatic mainland across the North Pacific is also important; rapidly moving HIGHS will bring more frequent changes in wind direction and consequently in the weather, than slow moving ones.

Any sketch of the rainfall of the Hawaiian group would be incomplete without special reference to that of leeward Hawaii, or the north and south Kona districts, respectively.

These districts are in the shadow of the great mountain masses of Mauna Loa and Mauna Kea, whose summits rise far above the upper limit of the northeast trades. These latter therefore are not in any way an important factor in the rainfall of the Kona districts.

I have just come across an account of the summer showers of leeward Hawaii written some 40 years ago by the late Maj. Clarence Edward Dutton, Ordnance Corps, United States Army, who made a geological reconnaissance in the islands in the early eighties.[4]

Major Dutton says in connection with his observations on the weather of the islands:

> I was much impressed with the fact that the trade wind is not felt on any of the high mountains above 7,000 to 8,000 feet. The upper part of this island [Mauna Loa] is in a region of comparative calm, excepting the uppermost 2,000 feet, where a gentle wind blows in a direction opposite to the trade wind.

His account of the weather of the Kona districts was evidently based on conversations with the inhabitants. It is summarized in the next paragraph.

> In the morning the sky is clear and the sun shines gloriously; after sunrise the air is dead calm, but about 10 o'clock the sea breeze sets in, blowing from the west, and ascends the mountain slopes. Quickly the clouds gather, and at length rain falls steadily throughout the afternoon and into the night. At 9 or 10 o'clock the wind ceases and the land breeze sets in. As a rule there is no rain at the lowest levels upon the margin of the sea. There is a narrow belt of land close to the ocean ranging in width from a mile to a mile and a half or even 2 miles where rain seldom falls. Here the slope is comparatively gentle and as the sea breeze blows inland the effect of the ascending current is not felt until the stronger slopes a couple of miles inland from the sea are encountered.

In the main this account faithfully describes the weather of Kona districts. A more recent statement is that supplied by Mr. Lawrence H. Daingerfield, who was in charge of the Hawaiian service from 1918 to 1922 and visited the Kona region in July 1922. In an unpublished letter to the editor Mr. Daingerfield says:

> From personal observations when in Kona and especially when ascending Mount Hualalai, 8,269 feet, in north Kona, I can say that I saw that there occurs a distinct strengthening of the southwesterly wind in the day time which brings in the clouds (forced cumuli I called them) and frequent showers. At the same time the trades brought in clouds from the northeast, and I observed the "battle of the clouds" on Hualalai Summit, a wonderful although not unusual occurrence at that point.

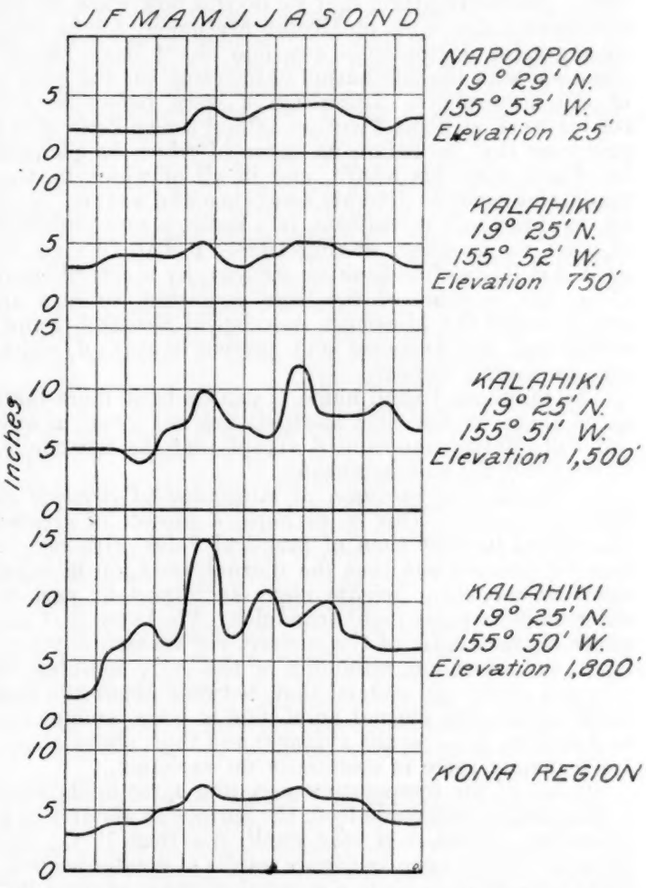

FIG. 4.—Monthly rainfall distribution in Kona districts of Hawaii

It has been definitely established that there is practically no wind in the Kona districts except the land and sea breezes, a condition that facilitates vertical convection in the daytime. The occurrence of thunderstorms in this region is also evidence of instability in the lower air levels. On the whole it is quite probable that vertical convection plays no unimportant part in the rainfall of the leeward districts of the Island of Hawaii.

In Figure 4 I present curves to illustrate the monthly rainfall distribution in south Kona. The top curve is that for Napoopoo, a station on the beach, as indicated by its geographical coordinates. Here there is a distinct increase in the rains of May with a diminished fall in June. The latter, however, is a month of minimum rain-

[4] C. E. Dutton, Hawaiian Volcanoes. Annual report, Director of U. S. Geological Survey, 1883, pp. 81–219.

fall in most of Hawaii. The next three curves are presented to show the marked influence of altitude, beginning with the Kalahiki station at 750 feet and followed by two other records in the immediate neighborhood at altitudes of 1,500 and 1,800 feet, respectively; and finally the curve at the bottom is a composite one made from all the available rainfall records of both north and south Kona. The bottom curve shows that the months of greatest rainfall coincide with the growing season of sugar cane in the Kona districts. These districts being in the shadow of the mountain masses of Mauna Kea and Mauna Loa are, as noted above, not subject to trade winds, and thus less moisture is lost by evaporation than in districts having a northeast exposure.

SOME OUTSTANDING AEROLOGICAL PROBLEMS

By WILLIS RAY GREGG

[Presented before the American Meteorological Society as a part of the "Meisinger Memorial," January 3, 1925, Washington]

It is a very good thing to pause occasionally in our work, take stock of what we are doing and endeavor to determine what new lines should be taken up and what changes, if any, in the old should be made. It is, I think, peculiarly fitting that we do this now when we are considering the work of Doctor Meisinger, for he was, to a greater degree than any one else I have known, absorbed with the fascination of ferreting out the secrets of the atmosphere. Less than a week before he left for his work at Scott Field we talked for an hour of the problems that lie before us, some of which he planned to attack upon his return, and in all of which he was ready and eager to give his assistance and advice. And so this brief talk constitutes, in a sense, a recapitulation of what we discussed at that time. I shall be glad indeed if it leads some aspiring student, by a contribution along one or more of the lines suggested, to earn an award under the Meisinger Aerological Research Fund, concerning the purposes and present status of which you are shortly to hear.

The problems I shall name (I can do little more than name them, in the time allotted) are not given in any order of relative importance, except that the last one is, to my mind, the *most* important.

1. *The diurnal variation of meteorological elements at different heights.*—This is, perhaps, a subject of greater theoretical interest than of practical value, although it may be pointed out that the diurnal variation in wind speed at moderate heights plays an important part in determining regular flight schedules. We know that the phase characteristic of the surface, viz, maximum velocity in the afternoon, minimum in the early morning, is reversed above 100 meters; that, between about 300 and 1,000 meters the diurnal amplitude is large, amounting to 3 or 4 m. p. s., on the average; and that, above about 1,500 meters there is essentially no variation.

Studies of the temperature variation agree in showing a diminishing amplitude from the surface to about 1 to 2 kilometers, where it is very small, less then 1° C., but these studies give contradictory results at greater heights. Some investigators claim a reversal of phase in these upper levels. More recent and more abundant data at Drexel and other stations in this country, however, indicate that the phase is essentially like that at the surface and that the amplitude is about 1° C. These later data represent practically all varieties of weather conditions, and the same results are shown for all parts of the year. The investigation is, however, in a preliminary stage only. It should be pushed to completion, and extended to the other meteorological elements, such as humidity, pressure, density, wind, etc. The data we now have, as the result of numerous series of successive kite flights covering periods of 24 to 30 hours, are ample for a complete and authoritative analysis of this problem.

2. *Winds and weather along airways.*—This is a problem of immediate practical value. In order intelligently to determine regular flight schedules for commercial or other purposes it is essential to know, for different sections of an airway, the resultant wind at flying levels, the percentage frequency of wind speeds above certain limiting values and the percentage frequency of occurrence of weather conditions, such as widespread heavy precipitation, blizzards, etc., that make flying impossible or at least hazardous. Studies along this line have already been completed for Oklahoma and east Texas and for the New York-Chicago airway. They should be extended to all sections of the country where regular flying, commercial or otherwise, is likely to develop, and preferably this should be done before such development takes place. For much of the eastern and central portions of the country suitable data for this problem are now available.

3. *The free-air in thunderstorms.*—Thunderstorms constitute the most difficult condition of the atmosphere to explore. For man-carrying aircraft to attempt this is suicidal; pilot balloons quickly disappear in the clouds, and even while in sight yield data of doubtful value, owing to vertical air movements, unless observed with two theodolites; and kite flying frequently results in destruction of the kite line and damage to the equipment, besides involving the possibility of injury to personnel. Nevertheless, a considerable mass of data has been collected, mostly perhaps immediately before and after the thunderstorms, but partly also within them. It is believed that an analysis of the data in hand would be fruitful, and would admirably supplement some recent statistical studies.

4. *Clouds.*—Notable contributions to this subject have been made in the past 30 years or so, and much of our knowledge of the larger features of the planetary circulation are based upon these studies. The field is far from exhausted, however. Little is known, for example, as to the average and extreme thickness of the different types, the variations in height, thickness and speed with latitude, in different parts of cyclones and anticyclones and in elevated as compared with low-lying regions. We need to know more than we do now with reference to lapse rates in clouds and their relation to precipitation. Data for these studies, although perhaps not adequate for a final settlement of them, are nevertheless quite abundant, through the observations we have made with kites and pilot balloons, and would, it is believed, well repay earnest effort on the part of those who can undertake their analysis. These data should of course be considered and combined with the results of earlier investigations, such as those of the International Cloud Years. The latter yielded information of immense value. It seems certain that the more recent data will supplement those where they were weak and bring the whole subject to a more satisfactory status than has heretofore been possible.

5. *The free air in the Tropics.*—The planetary circulation more closely approaches its ideal state in this region than in any other. It is here comparatively free from

disturbances such as the cyclones and anticyclones that characterize the temperate and subpolar zones. It is therefore an inviting field, but it must be explored more fully before it can be attacked and disposed of in anything like final form. Already, however, there is available a considerable amount of data, and some important contributions have been made, among the more recent being those of Van Bemmelen in Java and Harwood in India. In our own hemisphere we have a very good series of pilot-balloon observations at San Juan and Key West, and shorter series at Santo Domingo, Curacao, and the Canal Zone. Similar data have been obtained by this country in Hawaii and Guam. A study, based upon all this material, is now in preparation, but other studies from different angles would undoubtedly be fruitful. Unfortunately there are lacking temperature and humidity data, essential for any complete discussion. These can only be secured, so far as we know now, from sounding-balloon ascensions, and the prospect of work along this line at an early date is not promising. Nevertheless, the problem is presented at this time as an attractive one, since suitable data are available for preliminary discussions, and these will be of real aid in later studies when more data have been collected.

6. *The free air in the polar regions.*—This is certainly one of the most important problems before us, and, equally certain, its elucidation is one of the most difficult. It is important, particularly to us in this country and to our neighbors in Canada, because of the intimate relations between the weather along the polar-region border and our own subsequent weather. It is difficult, because the methods of exploration ordinarily employed are for the most part not suited to those regions. Thus, the use of sounding balloons would be very expensive, since very few would be found and returned. Because of remoteness from sources of supply and because of the severity of climatic conditions, kite flying would be extremely difficult. Pilot balloons alone would seem to be practicable, and even these would not be entirely satisfactory in winter, because of continuous or nearly continuous darkness. Besides, they give information as to wind conditions only. This problem can not therefore, at the present time, be presented to students. The necessary data for its solution must first be secured. It is a pleasure to note that a beginning has been made with pilot balloons by the Canadian Meteorological Service. It is our hope that this country may soon follow our neighbor's lead with similar observations in Alaska.

7. *The stratosphere.*—The two problems that I have just now presented include exploration and investigation of the stratosphere as well as of the troposphere. In the Tropics we have a splendid series of data at Batavia, and that is all, except a few scattering observations here and there. In the polar regions we have no data whatever for the stratosphere. Such data are urgently needed, for until they are at our disposal we are compelled to leave unfinished and uncertain *any* discussion of planetary circulation.

Even in our own latitudes, where observations at great heights can be most easily made, there is need for much more information than we at present possess. Some of the European countries have covered the field quite well. In the United States and Canada we have just about enough data to make us want more. We do not know at all precisely the latitudinal and annual variation in the height and temperature of the stratosphere. Similarly, the variation with surface pressure and temperature is not clear. Nor can we add materially to our knowledge in these matters by future studies of the data now available, for, owing to the revolutionary significance of this subject, it has elicited the interest of the world's ablest meteorologists, so that practically everything has been written that is possible until more complete and better distributed observations are secured. What we have in mind, so far as this country is concerned, is a number of series of simultaneous, daily soundings at a string of stations from North Dakota to Texas, at least four such series, well distributed through the year, each one covering at least a month. These should be followed by similar series near the Pacific and Atlantic coasts, and if possible there should be included extra observations at times of unusually interesting conditions at the surface; also several series of successive soundings at intervals of two or three hours for studies of the diurnal variation at great heights. This, it is true, is an ambitious program, but, equally true, it must be carried out before we can settle many of the questions that now perplex us. The problem can not be presented to students at this time, for, as earlier stated, about everything possible has already been done with the data available, but to students of the future it can be recommended as offering opportunity for the display of a high order of talent in research.

8. *The free air in cyclones and anticyclones.*—Happily, for this problem there is already available, in conveniently usable form, an abundance of data. Several contributions to the subject have been made and others are now in preparation, yet it can truly be said that we have barely scratched the surface. The origin, growth, and decay of these pressure systems, their direction and rate of movement, their height, the distribution of the meteorological elements in them at different heights, the variations in this distribution with latitude, season, topography, etc., and its relation to precipitation are only a few of the many phases of the subject that are worthy of the best efforts of well-trained students. More and more it is coming to be realized that the study of individual cases offers the most promising results. Some of us believe that Doctor Meisinger's analyses of three remarkable cyclones in the United States will occupy a high place in the final estimate of his contribution to meteorology. In these analyses he used all available cloud observations, and free-air temperature, pressure, humidity, and wind data from kite and pilot-balloon observations. This problem is presented as one of the most attractive at this time, because the necessary data are in large measure now available and because these systems, cyclones, and anticyclones, are the dominant features in our day-to-day weather.

9. *Application of free-air data to forecasting.*—Only a few of us are forecasters, and a still smaller number are conspicuously successful forecasters. Yet the chief end and aim of our meteorological existence is the accurate forecasting of weather. Certainly this is true of us in the Weather Bureau, as any one can see by a perusal of the organic act under which the bureau operates. Emphasis is there placed upon *forecasting*, almost to the exclusion of everything else. And it is right that this should be so. No matter what the lines along which our individual efforts are directed, they all finally meet and center in the Map Room. This problem then, the last that I am presenting, is thought to be by far the most important of all. Obviously, new light on those already named will contribute to the elucidation of this one, but just now we are considering the more direct and more specialized studies that should be made, and for which there are already abundant data.

It is generally accepted that the movements of cyclones and anticyclones bear a close relation to the air move-

ment in the upper levels. In the eastern and central portions of the United States this relation appears to be closest for cyclones at about 3 to 3½ kilometers and for anticyclones at about 1½ to 2 kilometers, somewhat higher in each case in summer than in winter. These are averages; in individual cases there are wide variations, owing chiefly to variations in temperature distribution, both horizontal and vertical. What is needed is an accurate representation of free-air pressures, and therefore winds, at different levels up to about 5 kilometers; in other words a series of synoptic maps for these levels similar and supplemental to the one regularly used for the sea level plane. It was to this problem that Doctor Meisinger applied his fine training and talents, and it was in an effort to secure additional data for its better understanding that he gave his life. He realized fully that he had made a beginning only, but he also believed, and many of us have the same conviction, that he was on the right track. Material modification would undoubtedly have to be made in details (Doctor Meisinger himself expected this), but the purpose and much of the general plan are undoubtedly sound. The purpose was not to have these free-air pressure maps take the place of actual observations, but to supplement them, since the latter can not always be made, at any rate with methods at present employed. This problem then is presented as the most important now before us—one demanding talents and training of the highest order.

Summary.—There are of course innumerable other problems awaiting our attention, but the emphasis in this paper is placed upon the word "outstanding." Of those presented there are seven for which data are already available, in part at least, viz, diurnal variation; winds and weather along airways; the free air in thunderstorms; in clouds; in the Tropics; and in cyclones and anticyclones; and the application of free-air data to forecasting. Studies along these lines have been and are being made but the field is wide open. The problems are especially recommended to graduate students who aspire to compete for grants from the Meisinger Aerological Research Fund. The purpose of that fund, as stated, is "the promotion of aerological research, * * * to the end that the type of research in which Doctor Meisinger was engaged shall be encouraged," and all of these problems meet that specification. Later, when the necessary data shall have been secured, the other two problems, viz, the free air in the polar regions and the stratosphere, will in their turn provide opportunity for researches which can hardly fail to yield results of far-reaching value in theoretical and applied meteorology.

AVERAGE FREE-AIR WINDS AT LANSING, MICH.

By C. L. RAY

[Weather Bureau Office, Lansing, Mich., January, 1925]

At the end of May, 1924, the pilot-balloon flights at the Lansing station had reached a total of approximately 2,100, covering a period of five years, June, 1919, to May, 1924, inclusive. These data have been summarized and the results are presented in this paper, which is, in some respects, a revision of an earlier paper of the same title,[1] although additional features, such as resultant winds, and a classification according to surface direction, are now included. The observations have in all cases been made with one theodolite, and the data are therefore subject to the errors of that method. From numerous two-theodolite observations it has been shown, however, that these errors are as a rule not large and that they are quite negligible when mean values are considered, as in the present paper.[2] Until August 1, 1921, two observations were made daily, at 7 a. m. and 3 p. m.; since that time there has been one only each day, that of the afternoon.

Lansing is located about midway between Lakes Michigan and Erie. Its geographic coordinates are: Altitude, 263 m.; latitude, 42° 44′ N; and longitude, 84° 26′ W. It lies close to the tracks of most of the cyclones that cross the country, with the exception of those that come up the Atlantic coast. The large percentage of days with precipitation or at least cloudiness and with strong winds, associated with these storms, renders the location unfavorable for the best results, so far as continuity of record and the attainment of a high average altitude are concerned. Nevertheless, the records of the period show that the loss of flights for all seasons is only 12 per cent. A maximum of 20 per cent reached during the winter months is balanced by a minimum of less than 5 per cent during the summer, while the spring and autumn show a failure to secure flights 11 per cent of the time.

Table 1 contains the seasonal and annual totals of all flights made during the five-year period. This total of more than 2,100 flights offers a satisfactory basis for the computation of average values. In the upper levels the number of flights available becomes smaller, as different things occur to terminate the individual ascensions. However, there are 1,007 observations at 3,000 meters, 682 at 4,000 meters, 489 at 5,000 meters, and 341 at 6,000 meters. At higher levels observations are too few to give dependable means. In all cases heights are given above the surface.

TABLE 1.—*Number of pilot-balloon ascensions, at Lansing, Mich.*

Altitude (meters)	Spring	Summer	Autumn	Winter	Annual
250	532	604	534	454	2,124
500	507	598	518	405	2,028
750	481	583	484	343	1,891
1,000	458	573	439	308	1,778
1,500	396	529	381	247	1,553
2,000	349	457	339	209	1,354
2,500	293	398	277	185	1,153
3,000	251	355	241	160	1,007
3,500	206	285	193	124	808
4,000	169	265	157	105	696
4,500	148	233	120	72	573
5,000	123	212	103	54	492
6,000	81	156	68	36	341

In Tables 2 and 3 are shown, respectively, the number of flights with differing surface directions and the percentage-frequency of winds from the various points of the compass. The percentage-frequency of winds from different directions at the surface and at 2 and 6 kilometers for the summer, the winter, and the year is also shown in Figure 1. It will be noted that during the spring months 45 per cent of the surface winds have a south component, during the summer 47 per cent, in the autumn 53 per cent, and in the winter 47 per cent. North surface components are observed 43 per cent of the time in the spring, 40 per cent in the summer, 30 per

[1] MO. WEATHER REV., December, 1922, **50**: 642-645.
[2] Haines, W. C., Ascensional Rate of Pilot Balloons. MO. WEATHER REV., May, 1924, **52**: 249-253.

cent in the autumn, and 36 per cent in the winter. At 4,000 meters 24 per cent of the winds are marked by a south component in the spring period, 18 per cent in the summer, 34 per cent in the autumn, and 16 per cent in the winter. A north component is observed 56 per cent of the time during the spring months at the 4-kilometer level, 66 per cent in the summer, 43 per cent in the autumn, and 56 per cent in the winter.

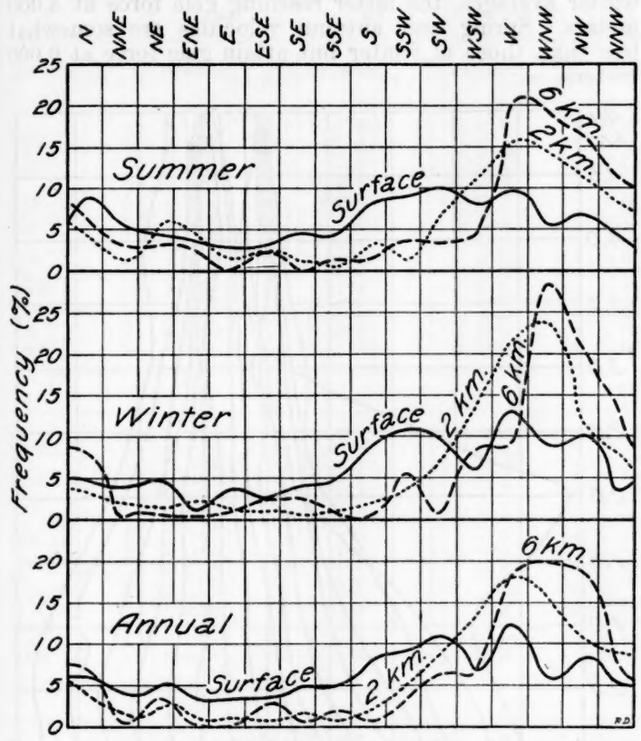

FIG. 1.—Percentage frequency of winds from different directions at the surface, 2 and 6 kilometers, at Lansing, Mich.

TABLE 2.—*Number of flights with different surface directions at Lansing, Mich.*

SPRING

Altitude m.	n.	nne.	ne.	ene.	e.	ese.	se.	sse.	s.	ssw.	sw.	wsw.	w.	wnw.	nw.	nnw.
250	29	24	36	22	22	14	26	26	45	43	48	32	47	46	40	20
500	20	14	35	26	21	12	20	15	18	42	58	45	62	40	40	27
750	16	17	25	25	20	16	16	14	13	34	60	44	60	40	46	23
1,000	18	21	15	18	19	13	13	10	10	25	60	47	64	34	50	29
2,000	24	12	14	6	8	10	5	6	4	17	36	39	52	37	39	28
3,000	15	15	7	4	6	1	4	5	5	9	19	23	43	22	44	18
4,000	10	6	4	3	4	2	2	5	2	6	9	12	31	21	28	16
5,000	6	5	4	1	1	4	4	0	3	6	4	10	18	22	19	12

SUMMER

250	37	48	34	23	19	20	16	29	33	30	52	64	60	50	45	30
500	34	40	36	19	20	21	21	17	32	27	49	68	64	56	50	30
750	40	29	37	21	13	20	15	23	29	21	49	57	76	61	47	32
1,000	39	25	36	13	24	13	13	16	22	30	37	58	81	72	44	37
2,000	33	8	25	15	8	11	7	7	12	8	30	53	68	71	54	35
3,000	19	7	19	4	5	8	6	4	1	8	19	45	50	59	56	35
4,000	13	11	10	5	2	2	4	4	3	4	12	20	39	69	41	18
5,000	13	8	6	7	2	2	2	1	5	2	6	18	34	45	36	17

TABLE 2.—*Number of flights with different surface directions at Lansing, Mich.*—Continued

AUTUMN

Altitude m.	n.	nne.	ne.	ene.	e.	ese.	se.	sse.	s.	ssw.	sw.	wsw.	w.	wnw.	nw.	nnw.
250	23	19	17	14	14	19	25	30	37	54	73	39	75	28	36	24
500	19	15	19	8	12	7	18	26	22	44	57	71	67	54	45	27
750	19	11	7	8	12	6	14	17	29	39	55	59	82	46	47	27
1,000	17	10	4	6	8	4	8	12	29	31	58	50	84	40	50	23
2,000	16	3	5	4	2	0	5	6	9	19	34	51	70	54	34	22
3,000	9	8	2	0	2	0	1	3	10	10	16	35	51	42	34	16
4,000	4	3	1	1	3	0	1	1	3	6	17	21	30	24	30	10
5,000	7	2	2	0	1	0	1	1	5	4	4	13	23	18	15	5

WINTER

250	17	17	17	12	12	15	12	14	26	36	44	45	63	48	42	23
500	17	15	12	7	10	13	9	10	24	15	39	56	61	50	36	20
750	19	4	6	5	13	5	9	8	10	19	24	52	52	46	42	18
1,000	11	7	8	3	9	6	3	8	8	12	23	41	38	39	46	15
2,000	6	3	2	4	2	2	1	0	2	6	10	29	46	45	24	17
3,000	6	2	3	2	1	3	1	0	0	3	8	13	42	33	25	10
4,000	7	1	1	2	1	0	0	0	1	2	7	6	27	22	18	5
5,000	5	0	0	2	1	0	0	0	0	1	2	3	11	8	9	7

ANNUAL

250	106	108	104	71	67	68	79	99	141	163	217	180	245	172	163	97
500	90	84	102	60	63	53	68	68	96	128	203	240	254	200	171	104
750	94	61	75	59	58	47	54	62	81	113	188	212	270	193	182	100
1,000	85	63	63	40	60	36	37	46	69	98	178	196	287	185	190	104
2,000	79	26	46	29	20	23	18	19	27	50	110	172	236	207	151	102
3,000	49	32	31	10	14	12	12	12	16	30	62	116	186	156	159	79
4,000	34	21	16	11	10	4	7	10	9	18	45	59	127	136	117	49
5,000	31	15	12	10	5	6	7	2	13	13	16	44	86	93	79	41

TABLE 3.—*Percentage frequency of winds observed from various directions at Lansing, Mich.*

SPRING

Altitude m.	n.	nne.	ne.	ene.	e.	ese.	se.	sse.	s.	ssw.	sw.	wsw.	w.	wnw.	nw.	nnw.
Surface	6	5	7	5	4	3	5	5	10	8	8	6	8	8	8	4
1,000	4	5	4	6	4	2	3	3	2	5	13	11	13	8	11	6
2,000	7	4	3	2	2	3	2	2	1	6	11	11	15	11	11	9
4,000	7	4	2	2	2	1	1	3	1	5	5	8	18	13	17	11
6,000	5	2	8	0	2	2	2	1	4	0	11	2	16	20	20	5

SUMMER

Surface	9	6	5	4	3	3	5	4	8	9	10	8	10	5	7	4
1,000	7	5	6	2	4	2	2	3	4	5	7	10	15	13	8	7
2,000	7	2	6	4	2	3	1	1	3	2	7	11	16	15	12	8
4,000	5	5	4	2	1	1	1	1	1	1	5	8	15	27	15	8
6,000	7	3	3	3	0	3	0	1	1	3	3	4	21	19	17	12

AUTUMN

Surface	4	3	3	3	3	4	5	6	7	10	14	7	14	5	7	5
1,000	4	2	1	1	2	1	2	3	6	7	13	13	19	9	12	5
2,000	5	1	2	1	1	0	2	2	3	5	10	15	20	17	10	6
4,000	2	1	1	1	2	0	1	1	2	4	11	15	19	15	18	7
6,000	9	3	4	0	0	1	0	0	1	3	4	12	24	18	17	4

WINTER

Surface	5	4	5	1	4	3	4	5	8	11	10	6	13	8	10	3
1,000	4	3	3	1	4	2	1	3	3	4	8	13	18	13	15	5
2,000	3	2	0	2	1	1	0	0	1	3	7	13	22	24	12	9
4,000	7	1	1	2	1	0	0	0	1	2	7	6	27	21	18	6
6,000	8	0	0	0	0	3	3	0	0	6	0	8	8	28	22	14

ANNUAL

Surface	5	5	5	3	3	3	4	5	7	8	10	9	12	8	8	5
1,000	5	4	4	2	3	2	2	3	4	6	10	11	16	11	11	6
2,000	6	2	4	2	2	2	1	1	2	4	8	13	18	16	11	8
4,000	5	3	2	2	1	1	1	1	1	3	7	9	19	20	18	7
6,000	7	3	2	2	1	1	2	0	3	3	3	9	18	20	17	9

35166—25†——2

In Table 4 and Figure 2 the mean free-air wind directions and velocities are given by seasons. It will be seen that at the surface the winds are between southwest and west and that the southerly influence is most pronounced in the autumn period. Above the surface there is on the average a gradual clockwise turning of the wind. During the autumn months a persistent westerly wind is to be observed up to 4,000 meters with a slight shift to WNW. above this height. In other seasons the north component is evident, beginning at about 2,000 meters, and the northwest trend becomes more strongly marked as the higher levels are reached.

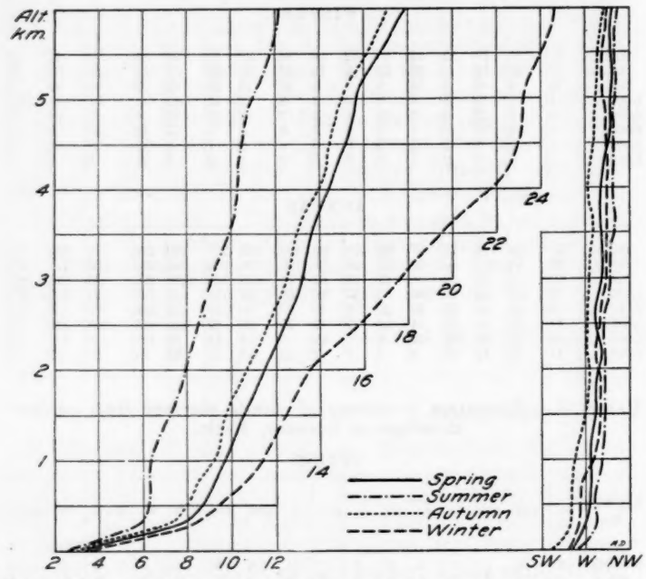

FIG. 2.—Mean seasonal free-air wind directions and speeds, m. p. s., at Lansing, Mich.

TABLE 4.—*Mean free-air winds at Lansing, Mich.*

Altitude	Spring		Summer		Autumn		Winter		Annual	
	Direction	Vel.	Direction	Vel.	Direction	Vel.	Direction	Vel.	Direction	Vel.
m.		*m. p. s.*		*m. p. s.*		*m. p. s.*		*m. p. s.*		*m. p. s.*
Surface	S. 75° W.	3.7	S. 85° W.	2.3	S. 61° W.	2.8	S. 74° W.	3.4	S. 74° W.	3.1
250	S. 87° W.	7.9	N. 78° W.	5.7	S. 75° W.	7.3	S. 84° W.	8.0	S. 87° W.	7.2
500	S. 88° W.	9.0	N. 78° W.	6.2	S. 80° W.	8.0	W.	9.7	W.	8.2
750	S. 88° W.	9.5	N. 74° W.	6.2	S. 79° W.	8.4	N. 84° W.	10.9	N. 88° W.	8.8
1,000	N. 79° W.	9.8	N. 72° W.	6.3	S. 82° W.	9.3	N. 81° W.	11.2	N. 82° W.	9.2
1,500	N. 74° W.	10.6	N. 71° W.	7.2	N. 89° W.	9.8	N. 75° W.	12.4	N. 77° W.	10.0
2,000	N. 75° W.	11.5	N. 67° W.	7.8	N. 85° W.	10.7	N. 74° W.	13.5	N. 75° W.	10.9
2,500	N. 74° W.	12.6	N. 68° W.	8.4	N. 84° W.	11.7	N. 74° W.	15.9	N. 75° W.	12.2
3,000	N. 65° W.	13.1	N. 65° W.	9.0	N. 82° W.	12.5	N. 69° W.	17.6	N. 70° W.	13.0
3,500	N. 67° W.	13.7	N. 60° W.	9.9	N. 81° W.	13.1	N. 70° W.	19.5	N. 70° W.	14.0
4,000	N. 67° W.	14.4	N. 61° W.	10.1	N. 82° W.	14.1	N. 69° W.	21.8	N. 70° W.	15.1
4,500	N. 64° W.	15.2	N. 60° W.	10.4	N. 77° W.	14.6	N. 61° W.	22.9	N. 66° W.	15.8
5,000	N. 68° W.	15.6	N. 60° W.	11.2	N. 72° W.	15.2	N. 57° W.	23.1	N. 64° W.	16.3
6,000	N. 66° W.	16.0	N. 58° W.	12.3	N. 67° W.	17.3	N. 57° W.	24.9	N. 62° W.	17.6

The average surface wind velocity is 3 meters per second, being slightly greater during the spring and winter and least in the summer. With increase of altitude the distinguishing features are the low summer and high winter averages, the latter reaching gale force at 3,000 meters. Spring and autumn velocities are somewhat less than those of winter but attain gale force at 6,000 meters.

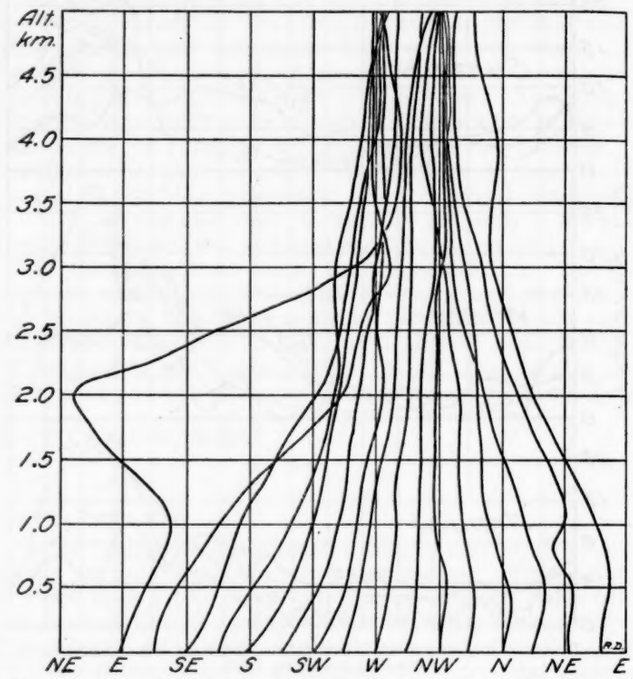

FIG. 3.—Mean annual free-air wind directions as related to surface directions at Lansing, Mich.

In Table 5 and Figure 3 are presented the wind averages grouped by the different surface directions. These show a turning of the north component winds to the left and of south component winds to the right, while east surface winds become somewhat variable with increase of altitude. These turnings continue until at the higher levels there is to be noted a grouping of the directions entirely between north and west. The velocities for all directions increase at about the same rate to the 500-meter level, above which west winds continue to increase in velocity while east winds decrease, with altitude, at the same time shifting to westerly. At 3,000 meters the mean direction of the winds, whatever the direction at the surface, is between WSW. and NNW., while at 5,000 meters the directions are limited by W. and NNW.

TABLE 5.—*Average direction and speed of free-air winds at Lansing, Mich., for different directions at the surface*

SPRING

Surface		Altitude (meters)															
		250		500		750		1,000		2,000		3,000		4,000		5,000	
Direction	Velocity (m. p. s.)	Direction	Velocity (m. p. s.)	Direction	Velocity (m. p. s.)	Direction	Velocity (m. p. s.)	Direction	Velocity (m. p. s.)	Direction	Velocity (m. p. s.)	Direction	Velocity (m. p. s.)	Direction	Velocity (m. p. s.)	Direction	Velocity (m. p. s.)
N	3.0	N. 5°W.	5.1	N. 10°W.	5.7	N. 21°W.	6.4	N. 16°W.	7.1	N. 19°W.	9.0	N. 23°W.	11.5	N. 41°W.	13.2	N. 46°W.	13.2
NNE	3.6	N. 30° E.	6.0	N. 37° E.	6.9	N. 33° E.	8.1	N. 21° E.	8.6	N. 5° E.	7.8	N. 17°W.	9.8	N. 41°W.	11.9	N. 40°W.	14.9
NE	3.4	N. 55° E.	7.5	N. 53° E.	8.2	N. 56° E.	8.3	N. 53° E.	8.4	N. 26° E.	8.3	N. 13°W.	9.8	N. 27°W.	11.6	N. 39°W.	13.6
ENE	3.1	N. 69° E.	6.8	N. 75° E.	6.8	N. 79° E.	6.6	N. 76° E.	6.6	N. 29°W.	7.7	N. 18°W.	8.5	N. 20°W.	9.6	N. 32° E.	10.8
E	3.6	S. 58° E.	7.4	N. 88° E.	8.1	S. 85° E.	8.2	S. 73° E.	7.8	S. 73° E.	6.5	N. 19°W.	5.5	N. 26° E.	6.6	S. 71°W.	9.5
ESE	3.1	S. 70° E.	6.6	S. 55° E.	7.5	S. 47° E.	7.1	S. 39° E.	7.0	S. 16° E.	8.1	S. 41°W.	8.4	S. 48°W.	9.4	S. 46°W.	10.4
SE	3.2	S. 40° E.	7.4	S. 33° E.	9.0	S. 29° E.	9.6	S. 29° E.	9.1	S. 36°W.	8.7	S. 50°W.	11.1	N. 67°W.	12.2	S. 80°W.	14.0
SSE	4.0	S. 15° E.	8.8	S. 13°W.	10.7	S. 13°W.	10.6	S. 29°W.	10.5	S. 74°W.	10.7	S. 76°W.	10.4	S. 79°W.	12.2	S. 82°W.	12.8
S	3.7	S. 18°W.	8.9	S. 28°W.	10.9	S. 34°W.	11.0	S. 41°W.	11.3	S. 58°W.	11.1	S. 73°W.	13.8	S. 68°W.	15.3	S. 74°W.	17.2
SSW	4.0	S. 40°W.	10.9	S. 44°W.	12.6	S. 51°W.	12.9	S. 58°W.	12.9	S. 71°W.	16.5	S. 83°W.	18.5	N. 83°W.	20.7	N. 78°W.	22.6
SW	3.7	S. 56°W.	9.0	S. 58°W.	10.6	S. 60°W.	10.9	S. 62°W.	11.2	S. 68°W.	13.0	S. 77°W.	13.9	S. 73°W.	15.8	S. 79°W.	17.2
WSW	4.0	S. 77°W.	10.0	S. 81°W.	11.0	S. 83°W.	12.3	S. 87°W.	11.3	N. 76°W.	15.9	N. 84°W.	17.7	N. 84°W.	19.5	N. 30°W.	20.4
W	4.2	N. 86°W.	8.7	N. 82°W.	9.4	N. 83°W.	9.9	N. 79°W.	10.8	N. 74°W.	13.6	N. 68°W.	14.5	N. 61°W.	17.9	N. 43°W.	19.7
WNW	4.8	N. 63°W.	8.5	N. 61°W.	9.5	N. 63°W.	11.5	N. 60°W.	10.3	N. 57°W.	14.0	N. 47°W.	15.8	N. 35°W.	18.0	N. 48°W.	18.8
NW	3.9	N. 40°W.	7.5	N. 43°W.	8.5	N. 39°W.	12.3	N. 42°W.	12.5	N. 36°W.	14.3	N. 35°W.	16.2	N. 33°W.	17.4	N. 49°W.	21.6
NNW	3.5	N. 30°W.	6.6	N. 31°W.	7.5	N. 37°W.	7.7	N. 30°W.	8.5	N. 31°W.	10.7	N. 31°W.	15.2	N. 34°W.	16.5	N. 45°W.	17.0

SUMMER

N	1.7	N. 6° E.	4.4	N. 5° E.	4.7	N. 3° E.	5.2	N. 1°W.	5.4	N. 17°W.	7.3	N. 35°W.	7.8	N. 29°W.	10.4	N. 37°W.	11.7
NNE	2.1	N. 21° E.	5.2	N. 25° E.	5.5	N. 21° E.	5.3	N. 10° E.	5.0	N. 6°W.	4.9	N. 47°W.	5.8	N. 30°W.	7.6	N. 49°W.	8.4
NE	2.0	N. 44° E.	5.3	N. 46° E.	5.4	N. 33° E.	5.4	N. 32° E.	5.0	N. 8° E.	6.3	N. 5°W.	7.9	N. 13°W.	9.7	N. 35°W.	10.9
ENE	2.3	N. 73° E.	5.2	N. 70° E.	5.8	N. 69° E.	5.8	N. 60° E.	5.6	N. 44° E.	5.8	N. 6°W.	4.3	N. 22°W.	7.3	N. 22°W.	9.6
E	1.9	S. 86° E.	4.9	S. 77° E.	4.4	S. 62° E.	4.0	S. 69° E.	4.4	N. 21° E.	5.0	N. 24° E.	5.8	N. 84°W.	5.2	N. 67°W.	5.8
ESE	1.6	S. 76° E.	3.2	S. 73° E.	3.3	S. 67° E.	3.6	S. 68° E.	3.9	N. 31°W.	5.5	N. 56°W.	5.2	N. 31°W.	6.6	N. 59°W.	5.8
SE	1.9	S. 27° E.	4.1	S. 24° E.	4.4	S. 18° E.	4.1	S. 9° E.	4.1	S. 27°W.	3.6	N. 69°W.	5.5	N. 69°W.	7.0	N. 76°W.	7.9
SSE	2.1	S. 7° E.	5.2	S. 1°W.	5.4	S. 10°W.	4.9	S. 25°W.	4.7	S. 47°W.	5.6	N. 25°W.	7.1	N. 72°W.	7.6	N. 75°W.	8.4
S	2.3	S. 11°W.	5.4	S. 18°W.	5.9	S. 16°W.	5.7	S. 40°W.	5.6	S. 61°W.	6.2	S. 76°W.	7.6	S. 83°W.	8.3	S. 87°W.	8.5
SSW	2.4	S. 47°W.	7.0	S. 54°W.	7.7	S. 60°W.	7.1	S. 63°W.	7.4	S. 86°W.	9.5	N. 85°W.	10.9	N. 73°W.	11.4	N. 54°W.	11.9
SW	2.3	S. 62°W.	6.5	S. 68°W.	7.6	S. 75°W.	8.1	S. 81°W.	8.5	W.	10.0	W.	10.8	N. 65°W.	11.7	N. 66°W.	12.8
WSW	2.5	S. 78°W.	6.4	S. 83°W.	7.0	S. 88°W.	7.9	W.	8.3	N. 81°W.	9.8	N. 64°W.	11.8	N. 72°W.	12.9	N. 63°W.	13.2
W	3.3	N. 85°W.	7.5	N. 85°W.	8.7	N. 84°W.	8.6	N. 85°W.	9.1	N. 74°W.	10.1	N. 76°W.	12.1	N. 76°W.	12.9	N. 71°W.	14.2
WNW	2.4	N. 61°W.	6.2	N. 63°W.	7.2	N. 66°W.	7.1	N. 65°W.	7.2	N. 70°W.	8.5	N. 65°W.	10.7	N. 59°W.	12.4	N. 60°W.	14.9
NW	3.0	N. 42°W.	6.1	N. 38°W.	6.5	N. 39°W.	6.6	N. 45°W.	7.5	N. 35°W.	10.9	N. 52°W.	13.7	N. 53°W.	15.6	N. 38°W.	17.3
NNW	2.6	N. 19°W.	5.5	N. 23°W.	6.4	N. 23°W.	6.6	N. 28°W.	6.7	N. 44°W.	9.1	N. 50°W.	10.7	N. 69°W.	11.7	N. 61°W.	14.0

AUTUMN

N	3.0	N. 7° E.	6.4	N. 5° E.	6.9	N. 2°W.	7.1	N. 14°W.	7.9	N. 17°W.	10.7	N. 23°W.	13.5	N. 11°W.	15.8	N. 24° E.	16.3
NNE	2.3	N. 27° E.	5.4	N. 33° E.	6.1	N. 18° E.	5.5	N. 10° E.	4.8	N. 45°W.	7.1	N. 40°W.	811	N. 43°W.	10.6	N. 27°W.	13.1
NE	2.3	N. 50° E.	6.2	N. 78° E.	6.3	N. 75° E.	6.6	N. 74° E.	7.2	S. 40°W.	6.5	S. 48°W.	9.3	S. 68°W.	10.3	S.	11.9
ENE	1.8	N. 66° E.	5.1	N. 65° E.	4.8	N. 62° E.	4.3	N. 46° E.	4.3	N. 23° E.	6.5	N.	8.0	N. 7°W.	9.4	N. 42°W.	10.8
E	2.1	S. 88° E.	5.0	S. 76° E.	5.0	S. 76° E.	4.1	S. 67° E.	4.7	N. 63°W.	5.3	N. 73°W.	6.7	N. 71°W.	9.6	N. 83°W.	9.9
ESE	1.9	S. 52° E.	6.6	S. 31° E.	7.9	S. 14° E.	8.4	S. 4° E.	8.3	S. 58°W.	9.3	S. 76°W.	8.4	N. 88°W.	9.1	S. 50°W.	10.0
SE	2.3	S. 24° E.	6.8	S. 16° E.	7.4	S. 5° E.	7.4	S. 3°W.	7.6	S. 52°W.	8.7	S. 57°W.	11.3	S. 64°W.	12.6	S. 83°W.	12.7
SSE	2.5	S. 5° E.	6.8	S. 6°W.	8.0	S. 17°W.	8.0	S. 40°W.	7.8	S. 54°W.	9.3	S. 74°W.	13.2	S. 76°W.	15.7	N. 77°W.	17.4
S	3.2	S. 14°W.	7.1	S. 25°W.	7.2	S. 26°W.	8.4	S. 30°W.	8.4	S. 49°W.	9.9	S. 69°W.	11.0	S. 77°W.	12.9	N. 82°W.	14.4
SSW	2.6	S. 44°W.	8.0	S. 53°W.	9.3	S. 58°W.	10.1	S. 63°W.	10.8	S. 77°W.	12.0	S. 85°W.	13.6	S. 89°W.	15.0	S. 82°W.	16.1
SW	3.0	S. 59°W.	8.5	S. 66°W.	10.1	S. 72°W.	11.0	S. 72°W.	11.4	S. 85°W.	13.3	S. 89°W.	14.8	S. 86°W.	15.9	W.	16.9
WSW	3.0	S. 74°W.	8.3	S. 78°W.	9.4	S. 72°W.	9.9	S. 77°W.	10.0	N. 88°W.	13.7	N. 76°W.	14.4	N. 64°W.	15.2	N. 38°W.	15.9
W	3.1	N. 87°W.	7.9	N. 86°W.	9.9	N. 86°W.	10.1	N. 82°W.	10.8	N. 70°W.	11.5	N. 60°W.	12.0	N. 56°W.	13.5	N. 50°W.	14.6
WNW	3.2	N. 60°W.	7.0	N. 58°W.	8.4	N. 53°W.	8.5	N. 53°W.	9.0	N. 54°W.	12.2	N. 51°W.	13.9	N. 48°W.	16.9	N. 6°W.	17.3
NW	3.4	N. 42°W.	7.5	N. 43°W.	8.8	N. 45°W.	11.6	N. 48°W.	12.7	N. 58°W.	15.2	N. 58°W.	16.9	N. 66°W.	20.2		21.1
NNW	2.8	N. 23°W.	5.6	N. 27°W.	6.1	N. 31°W.	7.4	N. 39°W.	8.4	N. 30°W.	11.8	N. 46°W.	12.6	N. 45°W.	15.5	N. 45°W.	16.6

WINTER

N	2.4	N. 4° E.	5.4	N. 1°W.	5.7	N. 9°W.	5.5	N. 21°W.	6.8	N. 31°W.	12.6	N. 37°W.	17.0	N. 42°W.	23.0	N. 67°W.	28.2
NNE	2.9	N. 45° E.	6.0	N. 50° E.	7.0	N. 41° E.	5.7	N. 37° E.	5.6	N. 27°W.	7.6	N. 41°W.	12.9	N. 34°W.	17.4	N. 46°W.	22.3
NE	3.5	N. 45° E.	6.6	N. 58° E.	7.1	N. 58° E.	7.2	N. 67° E.	7.0	N. 7° E.	7.8	N. 4° E.	7.9	N. 33°W.	10.2	N.	12.6
ENE	2.4	N. 78° E.	5.6	S. 89° E.	5.5	S. 68° E.	4.9	S. 21° E.	5.9	W.	6.1	N. 45°W.	7.8		12.3		14.2
E	3.0	S. 74° E.	6.9	S. 67° E.	9.2	S. 65° E.	8.3	S. 51° E.	7.1	S. 70°W.	5.6	N. 83°W.	10.6	N. 88°W.	14.6	S. 82°W.	18.5
ESE	2.3	S. 67° E.	5.9	S. 59° E.	6.6	S. 47° E.	7.4	S. 45° E.	6.8	S. 61°W.	6.8	S. 56°W.	10.0	S. 36°W.	13.2	S. 55°W.	15.9
SE	2.9	S. 27° E.	6.3	S. 7° E.	10.3	S. 27°W.	10.4	S. 36°W.	9.9	S. 64°W.	11.0	S. 83°W.	14.7	S. 74°W.	19.2		20.8
SSE	3.7	S. 7° E.	9.2	S. 13°W.	12.2	S. 24°W.	13.1	S. 37°W.	13.2	S. 73°W.	13.2	N. 87°W.	15.2	N. 82°W.	17.5	N. 67°W.	19.0
S	3.2	S. 21°W.	8.4	S. 37°W.	11.3	S. 50°W.	12.9	S. 60°W.	14.5	S. 86°W.	14.8	N. 86°W.	19.2	W.	24.1	N. 85°W.	26.3
SSW	3.1	S. 41°W.	8.6	S. 57°W.	10.8	S. 63°W.	13.1	S. 67°W.	13.2	S. 79°W.	14.6	W.	17.7	N. 81°W.	22.7	N. 78°W.	25.1
SW	3.4	S. 62°W.	11.6	S. 74°W.	12.0	S. 82°W.	11.6	W.	12.9	N. 75°W.	12.7	N. 76°W.	16.7	N. 67°W.	20.6	N. 63°W.	23.2
WSW	3.6	S. 78°W.	8.3	S. 88°W.	10.5	N. 83°W.	11.5	N. 74°W.	11.8	N. 79°W.	11.9	N. 69°W.	17.9	N. 68°W.	28.0	N. 45°W.	31.1
W	4.4	N. 84°W.	9.5	N. 80°W.	11.7	N. 73°W.	14.4	N. 76°W.	14.8	N. 68°W.	21.9	N. 71°W.	25.5	N. 59°W.	29.8		30.2
WNW	4.8	N. 62°W.	9.6	N. 60°W.	11.9	N. 58°W.	13.2	N. 58°W.	14.4	N. 67°W.	17.8	N. 10°W.	21.5	N.	23.7	N.	23.9
NW	3.2	N. 44°W.	6.9	N. 45°W.	8.8	N. 46°W.	9.6	N. 48°W.	10.5	N. 52°W.	14.9	N. 41°W.	18.9	N. 39°W.	23.2	N. 36°W.	26.2
NNW	3.0	N. 27°W.	6.3	N. 19°W.	7.0	N. 29°W.	9.4	N. 31°W.	10.8	N. 43°W.	15.9	N. 43°W.	20.8	N. 45°W.	26.7	N. 37°W.	28.4

ANNUAL

N	2.3	N. 8° E.	5.2	N. 1° E.	5.6	N. 5°W.	5.9	N. 13°W.	6.2	N. 20°W.	8.7	N. 28°W.	10.9	N. 45°W.	13.5	N. 40°W.	16.2
NNE	2.6	N. 27° E.	5.6	N. 32° E.	5.8	N. 22° E.	5.9	N. 14° E.	5.8	N. 19°W.	6.5	N. 37°W.	9.1	N. 40°W.	11.5	N. 43°W.	13.4
NE	2.8	N. 46° E.	6.5	N. 50° E.	7.0	N. 32° E.	7.0	N. 46° E.	7.1	N. 10° E.	7.5	N. 12°W.	8.9	N. 34°W.	11.1	N. 37°W.	12.7
ENE	2.4	N. 70° E.	5.6	N. 74° E.	5.9	N. 72° E.	5.7	N. 64° E.	5.9	N. 21° E.	6.6	N. 14°W.	7.1	N. 7°W.	9.0	N. 22°W.	10.5
E	2.6	S. 84° E.	5.9	S. 75° E.	6.2	S. 65° E.	6.0	S. 60° E.	5.8	N. 45° E.	5.7	S. 88°W.	6.5	N. 75°W.	8.0	N. 87°W.	9.8
ESE	2.2	S. 65° E.	5.6	S. 51° E.	6.1	S. 39° E.	6.3	S. 28° E.	6.4	S. 69°W.	7.0	N. 81°W.	7.2	S. 89°W.	8.2	S. 87°W.	8.7
SE	2.6	S. 30° E.	5.7	S. 25° E.	6.6	S. 14° E.	6.9	S. 11° E.	6.8	S. 50°W.	7.7	S. 71°W.	9.7	S. 89°W.	11.1	S. 88°W.	12.6
SSE	3.1	S. 9° E.	7.6	S. 3°W.	8.8	S. 13°W.	8.6	S. 30°W.	8.7	S. 62°W.	9.3	S. 69°W.	11.1	S. 85°W.	12.7	N. 77°W.	14.0
S	3.1	S. 19°W.	7.4	S. 27°W.	9.2	S. 33°W.	9.8	S. 44°W.	10.2	S. 66°W.	10.1	S. 76°W.	12.5	S. 85°W.	14.1	N. 84°W.	15.3
SSW	3.1	S. 42°W.	8.5	S. 51°W.	10 0	S. 57°W.	10.9	S. 62°W.	11.6	S. 78°W.	12.3	W.	14.6	N. 80°W.	16.9	N. 75°W.	17.8
SW	3.0	S. 60°W.	8.2	S. 67°W.	9.4	S. 69°W.	10.0	S. 72°W.	10.6	N. 85°W.	11.6	W.	13.3	N. 87°W.	14.8	N. 83°W.	16.4
WSW	3.3	S. 73°W.	8.6	S. 78°W.	9.4	S. 85°W.	10.3	S. 84°W.	10.4	N. 84°W.	12.9	N. 72°W.	15.3	N. 66°W.	16.6	N. 44°W.	17.5
W	3.7	N. 86°W.	8.3	N. 84°W.	9.6	N. 81°W.	10.3	N. 81°W.	10.9	N. 71°W.	12.8	N. 71°W.	15.7	N. 63°W.	17.7	N. 56°W.	19.1
WNW	4.2	N. 62°W.	7.8	N. 62°W.	9.2	N. 60°W.	9.2	N. 60°W.	9.5	N. 57°W.	12.7	N. 51°W.	15.7	N. 50°W.	17.7	N. 46°W.	19.1
NW	3.4	N. 43°W.	6.9	N. 43°W.	8.2	N. 46°W.	8.9	N. 47°W.	9.0	N. 51°W.	12.6	N. 51°W.	15.5	N. 46°W.	17.2	N. 42°W.	21.1
NNW	3.0	N. 23°W.	5.8	N. 25°W.	6.6	N. 29°W.	7.4	N. 32°W.	8.2	N. 35°W.	11.1	N. 43°W.	14.0	N. 56°W.	16.7	N. 54°W.	17.9

In Table 6 is given the percentage frequency of north and south components at 3,000 and 4,000 meters under differing conditions of wind direction at the surface. Here we find that with a north component at the surface the northerly influence persists 79 per cent of the time to 3,000 meters, and 80 per cent at 4,000 meters. With a south surface component the southerly influence continues at 3,000 meters in 39 per cent of all cases and at 4,000 meters in 33 per cent of all cases. With a west surface wind a north component prevails at 3,000 meters in 69 per cent of all times and at 4,000 meters the same percentage. The south component for west surface directions is noted 14 per cent of the time at 3,000 meters and 7 per cent at 4,000 meters. With west surface winds a due west direction may be expected in 17 per cent of all cases at 3,000 meters and 24 per cent at 4,000 meters. When all observations are considered, it is found that at 3,000 and 4,000 meters due west winds occur 19 per cent of the time, a north component 55 and 56 per cent, respectively, and a south component 26 and 25 per cent.

Table 7 contains a summary of resultant winds. A comparison of these figures with those in Table 4 is of interest. There is little difference in the directions shown, but the resultant speeds are decidedly lower than the average speeds at all levels, owing to the considerable number of times that east component winds, or at any rate winds at an appreciable angle from west to northwest (the resultant direction) occur, as indicated in Table 3. This difference in speeds diminishes with height, as the frequency of west-component winds increases.

TABLE 6.—*Annual percentage frequency of north and south components in winds at 3,000 and 4,000 meters, with different surface directions*

Direction at earth's surface	Number of observations	North component	South component	Due west
At 3,000 meters:				
E. to WSW	513	38	39	23
W	79	69	14	17
WNW. to ENE	323	79	9	19
All directions	915	55	26	12
At 4,000 meters:				
E. to WSW	350	45	33	24
W	45	69	7	24
WNW. to ENE	248	80	11	9
All directions	643	56	25	19

TABLE 7.—*Free-air resultant winds (m. p. s.) at Lansing, Mich.*

Altitude	Spring		Summer		Autumn		Winter		Annual	
	Direction	Vel.	Direction	Vel.	Direction	Vel.	Direction	Vel.	Direction	Vel.
m.		*m. p. s.*		*m. p. s.*		*m. p. s.*		*m. p. s.*		*m. p. s.*
Surface	S. 76°W.	0.9	S. 85°W.	0.2	S. 69°W.	1.1	S. 75°W.	1.3	S. 76°W.	0.9
250	S. 73°W.	2.6	N. 88°W.	2.2	S. 74°W.	3.4	S. 76°W.	3.5	S. 79°W.	2.9
500	S. 73°W.	3.0	N. 84°W.	2.6	S. 73°W.	3.4	S. 82°W.	5.2	S. 81°W.	3.6
750	S. 81°W.	3.5	N. 85°W.	2.8	S. 81°W.	4.7	S. 85°W.	6.1	S. 86°W.	4.3
1,000	S. 86°W.	4.2	N. 79°W.	3.0	S. 81°W.	5.7	N. 88°W.	7.8	W.	5.2
1,500	W.	5.7	N. 75°W.	3.9	W.	7.0	N. 79°W.	9.2	N. 84°W.	6.4
2,000	N. 83°W.	6.6	N. 71°W.	4.9	N. 88°W.	7.5	N. 78°W.	10.3	N. 80°W.	7.3
2,500	N. 77°W.	7.2	N. 69°W.	5.8	N. 83°W.	8.4	N. 74°W.	12.0	N. 76°W.	8.4
3,000	N. 70°W.	7.8	N. 65°W.	6.0	N. 83°W.	9.0	N. 71°W.	13.6	N. 72°W.	9.1
3,500	N. 62°W.	7.9	N. 61°W.	5.6	N. 77°W.	9.6	N. 69°W.	13.6	N. 67°W.	9.2
4,000	N. 67°W.	8.7	N. 62°W.	6.9	N. 80°W.	9.9	N. 66°W.	14.3	N. 69°W.	10.0
4,500	N. 63°W.	9.6	N. 60°W.	7.5	N. 79°W.	9.6	N. 63°W.	16.2	N. 66°W.	10.7
5,000	N. 62°W.	9.4	N. 58°W.	7.5	N. 77°W.	9.1	N. 55°W.	15.9	N. 63°W.	10.5
6,000	N. 61°W.	9.3	N. 58°W.	7.4	N. 70°W.	9.3	N. 56°W.	16.7	N. 61°W.	10.7

RECORDS OF TOTAL SOLAR RADIATION INTENSITY, AND THEIR RELATION TO DAYLIGHT INTENSITY[1]—A CORRECTION

By HERBERT H. KIMBALL

[Weather Bureau, Washington, February 12, 1925]

Dr. C. G. Abbot has kindly called my attention to the fact that footnote 14 on page 475 of the above-named paper does not apply to Mount Wilson. The data for Mount Wilson given in Table 1 on the same page were obtained from the Astronomical Journal for March 14, 1914, 28 : 133, and are based on bolometric measurements made on September 22 and 24, 1913. With respect to these measurements Dr. Abbot states:

> At that time the dust from Mount Katmai was still affecting the transparency and the larger part of the observations were made in the afternoon when the mountain is overlaid with haze which comes up with the sea breeze. The work was done employing the same quartz lens which was used on Mount Whitney. It is likely that these results and those for Mount Whitney, compared to others in your table, indicate too great brightness for the sky for this and three other reasons: First, the lens had a considerable number of striae which doubtless introduced some stray sunlight; in the second place, a thin quartz lens would be apt to transmit some radiation proper to the sky itself which during the afternoon might be warmed sufficiently to produce a positive deflection; and in the third place, the quartz lens is transparent to the extreme ultraviolet which would be cut off in the pyranometer experiments as also in the bolometric ones of 1905 and 1906 when glass was inserted. . . . If, owing to the circumstances I have related, it were recognized that some increase of the ratio factor for Mount Whitney and also for Mount Wilson is desirable, I believe the system [of ratios in Table 1] would be nearer the truth.

Reference to Figure 1 and Table 2, MONTHLY WEATHER REVIEW for November, 1924, **52** : 528, 529, shows that the means of pyrheliometric measurements of direct solar radiation made at Warsaw, Poland; Simla, India; Paris, France; Mount Weather, Va.; Kew Observatory, England; Madison, Wis.; and Santa Fe, N. Mex., give intensities in September, 1913, that are about 5 per cent less than the average for September under normal atmospheric conditions.

The probability that Doctor Abbot is correct in his statement is further strengthened by a consideration of the sky-brightness measurements made on Mount Wilson in 1905 and 1906. (See Annals of the Astrophysical Observatory, vol. 2, pp. 146–152.) These give for the ratios of Table 1, above quoted, for solar zenith distance 25°, 17.4, and for solar zenith distance 51.5°, 8.4. Therefore my statement on page 475 that the measurements for Hump Mountain "do not seem to be in accord with other measurements, since they show too little sky radiation" does not seem to be in accord with the facts as now set forth and should be stricken out.

[1] MO. WEATHER REV., October, 1924, **52**:473.

NOTES ON CHANGES IN SOME OF THE WEATHER ELEMENTS DURING THE SOLAR ECLIPSE OF JANUARY 24, 1925

By BURTON M. VARNEY

[Weather Bureau, Washington]

In connection with this eclipse, the officials in charge of Weather Bureau stations in and near the path of totality were asked to furnish reports of such meteorological and other observations as could be made without interfering with the regular work of the station. It is unfortunately not possible to publish these interesting reports in full. The following notes summarize the material relating to changes of pressure, temperature, and wind direction and velocity, from such reports as gave these items in sufficient detail to base a graphic representation on them, together with pertinent comments from other reports:

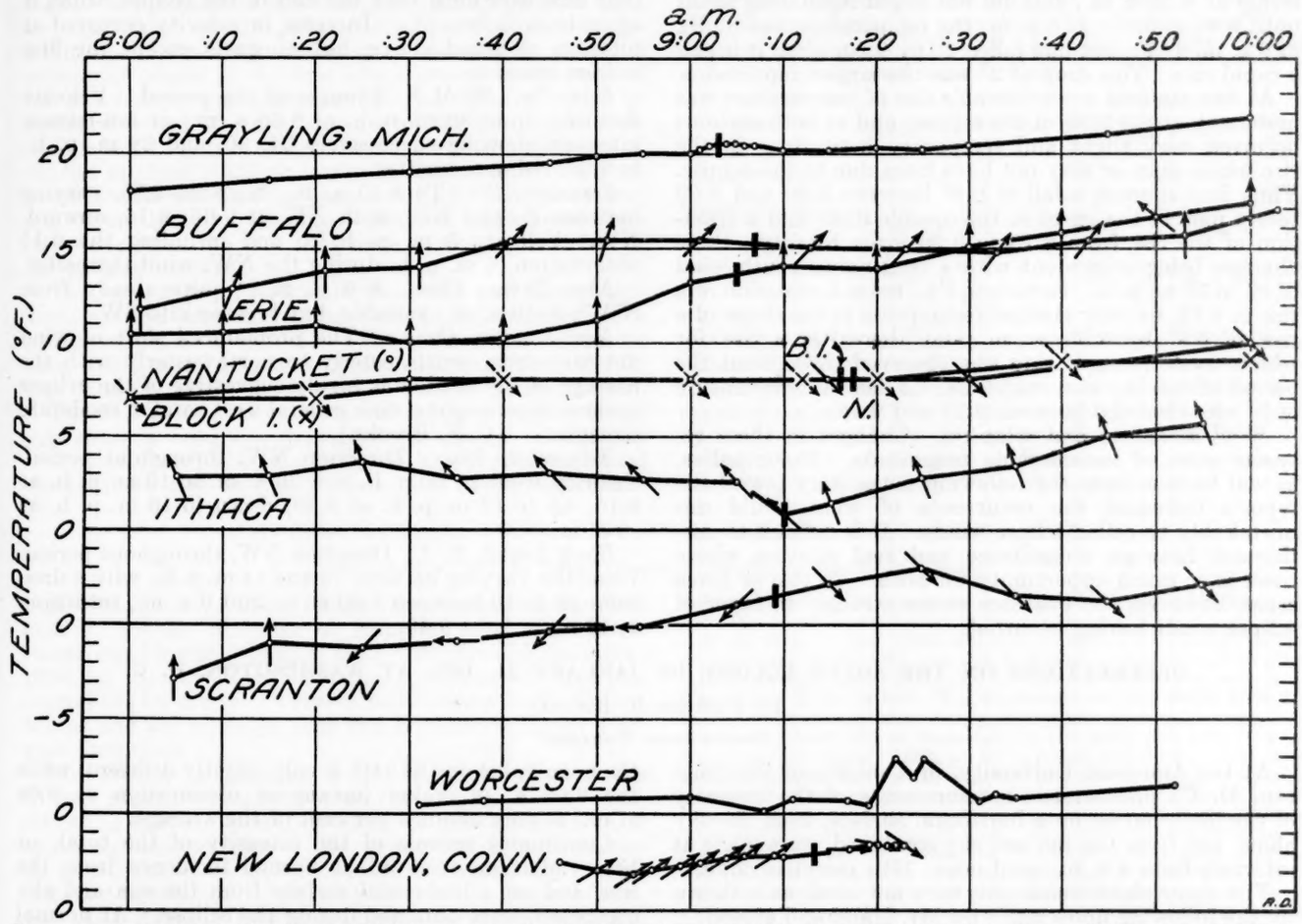

FIG. 1.—Temperature and wind directions at selected stations, during the solar eclipse of January 24, 1925. (Arrows fly with the wind. Heavy vertical bars show approximate time of middle of totality)

Pressure.—Only two stations noted changes in atmospheric pressure during the eclipse, which were of any apparent significance. Springfield, Ill., reported a moderate steady fall of pressure as being checked from 7 a. m. to about 9 a. m. Buffalo reported pressure declining until 15 minutes before totality, a rise of 0.02 inch at totality, followed after totality by a resumption of the fall. All other stations reported to the effect that there seemed to be no measurable influence on pressure as a result of the eclipse.

Temperature.—Nine reports included temperature readings beginning sometime before 8 a. m. and ending usually sometime after 10 a. m. Figure 1 represents these observations in graphic form (together with wind directions), on a vertical scale suitable for showing tenths of a degree F. change.

It will be noted that most of the observed changes at or near totality are of less than 1° F. in magnitude. Some of them are rather to be described as temporary cessations in a general forenoon rise. At some stations a decrease in the rate of rise took place well in advance of totality. It is impossible, however, to say how much, if any, of this change was due to the advance of the eclipse, and how much to cloudiness. Thus at Grayling, Mich., the sky was uniformly covered by a sheet of A. St. during the whole period. At Buffalo the sky was 0.9 obscured by 7:30 a. m., though the sun shone through an opening in the southeast until 8 a. m., after which it never appeared again until totality, during which at three times it appeared through rifts in the clouds. At Ithaca, the maximum observed temperature during the period occurred at 8:25, the sun having become partially obscured by A. St., which, however, had largely become dissipated by the time totality occurred. The temperature slowly fell as the clearing proceeded. How much of this fall one may ascribe to the progress of the eclipse and how

much to an increase of radiation from the earth's surface induced by the clearing is impossible to say. About the drop of 1.6° at totality, on the other hand, there can be little doubt. It was one of the two largest of those reported, and was accompanied by a very noticeable increase in wind velocity as attested by several observers (from a measured velocity of 16 m. p. h. just before totality to an estimated velocity of 20 m. p. h. shortly after). Of the temperature changes at New Haven there can be little doubt that they were due directly to the eclipse. "At 8 a. m. the sun was shining through thin clouds and in a few minutes they had so scattered as not to interfere with perfect vision during the time of the eclipse." "The sunshine recorder stopped registering at 8:35 a. m., and did not begin registering again until 9:45 a. m." At 8 a. m. the temperature was 3° F., at 9 a. m. 4° F., but had fallen 2° by 9:30, when it began a rapid rise. This drop of 2° was the largest reported.

At two stations a considerable rise of temperature was underway at the time of the eclipse, and at both stations occurred very slight and temporary hesitations in the rise which may or may not have been due to the eclipse. Thus Erie showed a fall of 0.8° between 8:20 and 8:30 (early part of the onset of the moon's disk) and a cessation of the rise from 9:10 to 9:20 (*after* totality), these changes being coincident with a continuous south wind of 27 to 35 m. p. h. Scranton, Pa., notes a cessation of a rise at 8:15, its very gradual resumption in the shape of a rise of 0.9° by 8:55 a. m. and thereafter a rise for which no decrease of rate was observed throughout the period of totality nor until 9:25. A fall of temperature of 2° was observed between 9:25 and 9:45.

Wind directions and velocities.—Changes in these respects were of considerable magnitude. Nevertheless, as will be seen from the following notes, very few of the reports indicated the occurrence of what could unmistakably be called eclipse winds. It is difficult to distinguish between coincidence and real relation where there is so much opportunity for both. In two or three cases, however, the evidence seems strongly in favor of eclipse winds having occurred.

Grayling, Mich.: 8 a. m., moderate S. wind, overcast sky. During totality, a snow flurry of about three minutes' duration, when it seemed "very windy." 9:07, "fresh wind"; 9:10, "wind continues"; 9:20, "wind less"; 10, "wind much lighter."

Buffalo, N. Y.: A 23 m. p. h. average velocity "up to the time of the eclipse," decreased to 12 m. p. h. at five minutes after totality, and increased thereafter to an average of 18 m. p. h. *Wind veered* from S. at 8:30 to SW. and SSW. during the eclipse until 9:53, when S. wind was again recorded.

Ithaca, N. Y.: Wind SE. from about 7:30 to about 8 a. m., SSE. from about 8 to about 8:30, SE. thereafter until about 9:15, when it *veered* to SSE., remaining in that direction until near the end of the eclipse, when it again backed into SE. Increase in velocity occurred at totality, as noted above, but no gusts except the first sudden increase.

Erie, Pa.: Wind S. throughout the period. Velocity declining from 36 m. p. h. at 8:50 a. m., at ten-minute intervals showing successively 34, 30, and 28 m. p. h., to 9:20, rising thereafter.

Scranton, Pa.: To 8:15 a. m., S.; 8:25–9.05, varying between E. and NE., with NE. at 9:05; 9:15, onward, NW. Velocity 3 m. p. h. to and including the 9:15 observation, 4 m. p. h. during the NW. wind thereafter.

New Haven, Conn.: 8–9 a. m., "quite steady from NW"; 9–10 a. m., variable, but *backing* into SW.

New London, Conn.: "The pronounced shift of wind direction from southwesterly to northwesterly with the passage of the shadow is highly suggestive of the eclipse cyclone superimposed on a general west wind of moderate strength." (C. F. Brooks.)

Nantucket, Mass.: Direction NW. throughout period. Velocity from 14 m. p. h. at 8:30 a. m. to 10 m. p. h. at 9:15; up to 13 m. p. h. at 9:30; down to 10 m. p. h. at 10 a. m.

Block Island, R. I.: Direction NW. throughout period. Velocities varying between 12 and 14 m. p. h., with a drop from 12 to 10 between 8:40 a. m. and 9 a. m., returning to 12 m. p. h. at 9:40.

OBSERVATIONS ON THE SOLAR ECLIPSE OF JANUARY 24, 1925, AT WASHINGTON, D. C.

By HERBERT H. KIMBALL

[Weather Bureau, Washington]

At the American University, in a suburb of Washington, D. C., photometric measurements of the intensity of the illumination on a horizontal surface, from the sky alone, and from the sun and sky combined, were made at intervals from 8 a. m. until noon, 75th meridian time.

The atmospheric conditions were not ideal, as is shown by the following notes made by Mr. Hand and myself:

7:30 a. m.: A few clouds on SE. horizon. Low dense smoke, above which the tops of the Arlington towers were visible.

7:50 a. m.: Few clouds on NW. horizon. Sky overhead streaked with smoke. Sun emerging from dense smoke cloud over city.

8:00 a. m.: Smoke rising; Arlington radio towers and clouds on horizon obscured. Distinct odor of coal gas.

9:35 a. m.: Wind driving smoke away. Arlington towers again visible.

12 noon: Smoke still present, but quantity greatly diminished.

The intensity of daylight illumination on a horizontal surface at 8 a. m. was 352 foot-candles; at 9:08 a. m., 89 foot-candles; at noon, 5,000 foot-candles. Compared with average values on clear days at this time of the year the noon value on the 24th is only slightly deficient, while the 9:08 a. m. value (maximum obscuration at 9:04 a. m.) is only about 4 per cent of the average.

Continuous records of the intensity of the total, or heat radiation, received at normal incidence from the sun, and on a horizontal surface from the sun and sky combined, were obtained during the eclipse. At normal incidence the intensity was about 0.02 gram-calories per minute per square centimeter, and on a horizontal surface about 0.01 gram-calorie, or 3 and 3.5 per cent, respectively, of the intensities that would have occurred had there been no eclipse. These latter values have been obtained by interpolation between measurements made just before first contact and after fourth contact in the case of the intensity at normal incidence, and by comparison with the thermoelectric pyrheliometer record for the following day in the case of the intensity on a horizontal surface. In appearance, the sky on the morning of the 25th was of about the same character as on the 24th.

The combined evidence of the measurements of solar radiation intensities by both photometric and pyrheliometric methods is to the effect that if the moon eclipsed 95 per cent of the sun's disk at the time of maximum

obscuration, as was predicted, the limb of the sun is cooler than its center, as we have abundant reason to suppose.

At the New York Meteorological Observatory, Central Park, New York City, where the eclipse was very nearly total, the radiation at the time of maximum obscuration was almost negligible. It did not exceed 0.002 gram-calories per minute per square centimeter or about 1 per cent of the radiation intensity we would have expected had there been no eclipse.

SPECIAL AEROLOGICAL OBSERVATIONS DURING THE SOLAR ECLIPSE OF JANUARY 24, 1925

By L. T. SAMUELS

[Weather Bureau, Washington, D. C.]

Instructions were issued to the six aerological stations to begin their kite flights on this day in time for the kites to attain their greatest possible altitude from one-half to one hour before the eclipse began. This altitude was to be maintained as nearly constant as possible until an equal lapse of time after the eclipse had ended. In addition to the single Marvin meteorograph which is ordinarily placed in the first kite a second instrument of the same type was placed in the last kite in order to obtain a record of conditions nearer the ground as well.

The fact that this eclipse occurred so near the time of sunrise at these stations, however, rendered the observations far less satisfactory than if it had taken place several hours later in the day. Another unfortunate circumstance was the fact that none of the stations lay in the path of totality.

The records from Ellendale, N. Dak., and Groesbeck, Tex., are the only ones which contain any evidence of a probable positive nature. The table given contains data which were obtained by the instrument in the last kite or that nearest the ground at each of these stations.

The fall in temperature at Ellendale is rather striking, since it occurs with very little change in altitude and coincides with a retardation in the ordinary diurnal temperature rise at the surface. It seems significant that, as indicated in the table, there was an almost complete recovery of temperature at this station within a short time following the eclipse. It is interesting also to note in this connection that the corresponding change in relative humidity is not as great as such a temperature change demands, providing the absolute humidity remains unchanged. In this case, however, the latter apparently decreased considerably.

	Time, a. m.	Altitude	Temperature	Relative humidity	Vapor pressure	Wind direction	Wind velocity
		m.	*° C.*	*Per cent*	*mb.*		*m. p. s.*
Ellendale, N. Dak.	8:02	495	−2.2	70	3.75	WNW	11.3
	8:39	533	−7.0	72	2.45	WNW	10.8
	9:14	557	−4.7	73	3.02	WNW	11.3
Groesbeck, Tex.	7:46	683	8.5	33	3.66	W	10.8
	8:08	741	9.0	25	2.87	W	10.4
	8:48	752	8.1	28	3.02	W	10.4

At Groesbeck a fall in temperature is also noted, although of lesser magnitude. At this station, however, the surface temperature dropped about 1° F. during the maximum phase of the eclipse, shortly after it had started upward in its ordinary diurnal march.

The degrees of totality at Ellendale and Groesbeck were 95 per cent and 65 per cent, respectively.

METEOROLOGICAL CONDITIONS ON BAKER AND HOWLAND ISLANDS

[Extracted from a report by Walter G. Ramsay, Weather Bureau Office, Honolulu, Hawaii]

A scientific expedition under the auspices of the Bernice P. Bishop Museum of Honolulu, Hawaii, visited Baker and Howland Islands the latter part of September, 1924, for the purpose of collecting specimens of plant and animal life for study. These islands belong to the United States and are situated near the Equator in about 178° west longitude.

Mr. Walter G. Ramsay of the Honolulu office of the United States Weather Bureau, accompanied the expedition as meteorologist, detailed to make surface and upper-air observations. The expedition left Honolulu on board the U. S. S. *Whippoorwill* September 15 and returned October 7. One day was spent on Baker Island, and three days on Howland Island, the latter being the larger of the two.

The following excerpts (certain changes having been made in the sequence of the items), are taken from Mr. Ramsay's report to the Bishop Museum:

Observations of wind directions and velocities taken by ships in the vicinity of these islands during the past few years, and tabulated by the United States Weather Bureau, indicate that the two islands are practically between the northeast trades and southeast trades. During the months June to November, inclusive, when the northeast trades are farthest north, the islands are on the edge of the southeast trade winds; during December to May when the northeast trades are closest to the Equator, they are on the edge of the northeast trades. At no time of year are they in the so-called doldrums, or belt of equatorial calms. In fact, the doldrums do not seem to exist as far west as these islands.

At all times of year, whether under the influence of the northeast or southeast trades, the prevailing direction of the wind in this vicinity is east, with a northerly tendency in the former case, and a southerly in the latter. The maximum velocity varies from 15 to 25 miles an hour, with comparatively few calms each year.

On the recent trip to these islands the wind was found to be comparatively steady both as to direction and force. The prevailing direction was slightly south of east during the daytime, and is believed to have veered somewhat at night, shifting to southwest for a short time. The highest velocity was attained during midafternoon, and was about 15 miles an hour. Shortly before sunset the wind died down, the velocity remaining low until shortly after sunrise, when it again increased to its usual velocity of 8 to 10 miles an hour.

As the accompanying tables of temperature readings show, there was quite a large daily range between maximum and minimum temperatures, on Howland Island. As no maximum or minimum thermometers were carried on the expedition, it is impossible to state exactly either the maximum or minimum temperatures. However, the observer feels positive that the maximum and minimum temperatures as estimated are conservative rather than extreme, and are not in error more than half a degree. From them the range is seen to be 16° or 17°. This is not what was expected. At Honolulu the range is seldom more than 9° or 10°, and as these islands are quite small it was not expected that there would be more than 6° or 8° difference in temperature between night and day readings. The temperature of the water, probably, does not vary more than 2° or 3°. It would seem that the coral sands of which the island is composed quickly absorb considerable heat during the day, raising the daytime temperature, and once the sun has set quickly radiate their heat, lowering the temperature during the late night.

TABLE 1.—*Weather conditions, Howland Island, September 26–27, 1924*

Time	Temperature	Humidity	Wind	Velocity	Clouds
				mi. per hr.	
Sept. 26 [1]					
6:00 a. m.	82	74	SE.	10	4 Ci. SW., 2 Ci. St. SW., 1 Cu. E.
8:00 a. m.	86	64	E.	8	7 Ci. SW., 1 Cu. E.
10:00 a. m.	90	56	E.	8	8 Ci. St. SW., few Cu. E.
11:00 a. m.	92	57	E.	10	7 Ci. St. SW., few Cu. E.
12:00 noon	90	56	E.	8	3 Ci. St. SW., 1 Cu. E.
2:00 p. m.	92	55	E.	10	1 Ci. St. SW.
4:00 p. m.	86	66	ESE.	10	3 Ci. S., 1 Cu. NE.
4:30 p. m.	84	69	ESE.	10	4 Ci. S., 1 Cu. E.
5:00 p. m.	82	72	ESE.	10	2 Ci. SW., 1 Cu. E.
6:00 p. m.	80	75	ESE.	6	5 Ci. SE., 1 Cu. E.
Sept. 27 [2]					
6:00 a. m.	79	86	SE.	2	6 Cu. SE.
6:30 a. m.	82	76	E.	4	5 Cu. SE.
7:00 a. m.	82	78	E.	4	2 Cu. E.
8:00 a. m.	86	75	E.	6	2 Cu. E.
9:00 a. m.	88	77	E.	6	2 Cu. E.
10:00 a. m.	90	78	E.	6	1 Cu. E.
11:30 a. m.	94	61	E.	6	3 Cu. E.
12:00 noon	94	66	E.	8	4 Cu. E.
2:00 p. m.	88	72	E.	8	2 Cu. E.
4:00 p. m.	86	70	E.	8	1 Cu. E.

[1] Maximum temperature for the day, estimated, 93°; minimum, estimated, 78°. No rain fell on island, but several rain squalls occurred over the ocean in the near vicinity.
[2] Maximum temperature for day, estimated, 95°; minimum temperature, estimated, 78°. No rain fell on the island, but there were several rain squalls during the night over the surrounding ocean.

Cloudiness was greatest on the islands during the night, and least in the early afternoon or late morning. About 4 o'clock in the afternoon the clouds—huge, towering cumuli—began to form, and by sunset a considerable portion of the sky was covered with them. Shortly after sunrise they disappeared, somewhat, so that during the day what clouds there were were small. Considerable cirrus cloud was observed at times during the stay on the islands. The lack of cloudiness during the day was another point in which actual conditions showed themselves to be different from expected conditions.

Humidity variation was not very great, as the table shows, the highest reading, of course, being at night and the lowest during the early afternoon. Far lower humidity was found to prevail on the island than had been expected, however. During the stay on the islands no rain fell. From the appearance and scantiness of the vegetation it is doubtful if as much as 3 inches of rain falls on the islands in a year. However, this is nothing more than a guess, there being nothing tangible on which to base a conclusion.

From the 14 observations of upper-air wind directions and velocities very little could be learned. The balloons were carried away too quickly to be followed for any great length of time. In addition it is thought that water vapor in the lower air, caused by evaporation from the ocean's surface, caused a hazy condition which interfered materially with the observation of the balloons. The highest altitude reached with a balloon was 2,320 meters (7,612 feet), at which altitude the direction of the wind was 83°, [north being 0°] compared with 85° at the surface; the velocity was 9.8 meters per second (22 miles an hour). The highest velocity encountered during any of the balloon observations was 17.6 meters per second (39 miles an hour). This was found at an altitude of 1,680 meters (5,512 feet).

TABLE 2.—*Average velocity and direction of wind at various altitudes, Howland Island, September 26, 27, 1924*

Minutes of observations	Altitude *Meters*	Velocity *m. p. s.*	Direction (north=0°)
0	0	3.7	90
1	192	9.6	100
2	368	9.2	101
3	544	9.3	101
4	712	9.8	99
5	880	10.4	98
6	1,040	9.7	96
7	1,200	10.9	93
8	1,360	10.6	100
9	1,520	10.8	98

Two facts of interest were gathered from the balloon observations: First, that the velocity of the balloon at the end of the first minute of observation, when about 190 meters (623 feet) above the surface was considerably greater than the velocity at the surface. An outstanding example of this was the first observation made, with a velocity at the surface of 3.6 meters per second (8 miles an hour) and a velocity at the end of the first minute of 14.0 meters per second (31 miles and hour). The average velocity of the wind at the surface for the 14 observations was 3.7 meters per second (8 miles and hour) and at the end of the first minute it was 9.6 meters per second (22 miles an hour). In most cases the velocity at the end of the second minute was somewhat less than at the end of the first. The second point in the balloon observations worthy of note was the steadiness of direction of the wind. At all times throughout the course of the balloons' flights the wind blew from a point within a few degrees of east. During the course of any one balloon flight the direction of the wind at various altitudes varied, on an average, only 7°. The greatest variation in any one run was 19°. Although no definite tendency of the wind in the course of the flights either to veer or to back can be claimed, the wind backed in more cases than it veered. That is (see table) starting with a surface wind from 90°, at the end of the first minute it had veered to 100°; at the end of the second it had veered to 101°; at the end of the third it was 101°; and then it commenced to back, first 99°, then 98°, next 96°, and so on.

Conditions as found on the islands might be summed up thus: Maximum temperature, about 94°, minimum about 78°; humidity comparatively low; wind, prevailing from the east, varying slightly during the daytime and backing to southwest for a short time at night; highest velocity about 15 miles an hour in early afternoon, falling to 3 or 4 miles an hour at night; sky partly cloudy to cloudy at night, and from 8 in the morning until 4 in the afternoon, clear, with only small clouds floating by; barometric pressure quite constant, varying only diurnally.

A 55-YEAR RECORD OF RAINFALL IN BERMUDA

Mr. William H. Potter, of Washington, D. C., has very kindly taken the trouble to compile and send to the REVIEW a valuable record of Bermuda rainfall, which we are glad of having the opportunity to make available in permanent form. The following explanatory notes are quoted from Mr. Potter's letter accompanying the record:

The records from 1870 to 1896 inclusive were copied from those published in the Bermuda Almanack of current dates and were taken by a Mr. Gosling. The records seem to have been carefully taken and show no great discrepancies. The amounts seem a little large in comparison with the later records, but I think they are fully as reliable as any old records taken by an amateur. The records from 1897 on were taken from those of the Prospect Observatory as published in the Colonial Blue Book, but supplemented in a large part by personal investigation of the original records. * * * No attempt has been made at the Observatory to make and keep a summarized record of the observations. * * *

There have been other records of rainfall in Bermuda, some taken by the Royal Engineers from 1855 to the eighties but not consecutively; another set, 1855 to 1862, by the Navy at the dockyard, but neither of these sets seems to me to be very reliable.

The importance of the records I am sending lies in the fact that they are taken in a spot on the globe where it is practically impossible to get records within about 700 miles in one direction and much farther in the others, and my object in sending them * * * is to have them placed on record permanently * * * for the sources from which I compiled them are scattered and difficult to get at.

TABLE 1.—*Monthly and annual amounts and averages of rainfall at Hamilton, Bermuda, 1870–1924*

[Values for 1870–1896 from observations by Mr. Gosling published in the Bermuda Almanack; for 1897–1924 from the Colonial Blue Book, supplemented by investigation of original records at the Prospect Observatory, Bermuda]

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1870	5.54	7.00	5.58	3.21	5.20	2.94	1.92	2.23	7.32	1.18	4.21	5.67	52.00
1871	1.50	1.19	3.21	5.20	3.64	3.63	4.57	4.37	4.65	3.86	5.11	6.06	46.99
1872	4.31	4.17	6.61	6.26	1.28	4.96	9.48	8.03	4.64	6.53	4.12	8.02	68.41
1873	6.72	6.96	6.97	4.41	7.21	2.31	4.46	1.95	1.83	2.46	6.32	5.06	56.66
1874	3.51	4.75	6.43	2.25	2.45	3.83	5.68	11.30	5.85	16.50	5.40	3.25	71.20
1875	2.50	2.56	1.78	5.00	6.33	1.88	4.17	1.75	5.69	6.45	2.42	4.30	44.83
1876	1.66	4.47	5.80	3.51	5.59	8.41	2.56	1.52	7.59	7.00	4.14	7.35	59.60
1877	2.97	11.00	6.13	2.45	6.94	7.01	4.73	8.84	4.45	1.33	6.53	3.43	65.81
1878	5.79	7.80	5.81	3.41	4.10	5.47	5.68	9.69	5.98	5.38	5.78	3.36	68.25
1879	4.64	5.55	5.04	3.52	4.89	4.21	8.59	4.67	5.39	2.76	3.58	3.15	55.99
1880	3.44	4.45	3.07	1.57	3.84	3.20	4.19	6.23	2.70	7.97	5.66	5.99	52.31
1881	3.45	2.89	8.05	3.11	3.30	5.80	7.65	4.44	5.45	3.14	2.67	6.67	56.62
1882	3.80	3.07	4.46	2.47	9.13	3.68	6.74	6.04	6.40	5.87	8.61	4.53	64.80
1883	1.39	0.96	5.64	3.21	6.07	3.52	6.37	3.27	2.76	10.74	3.14	5.99	53.06
1884	3.97	3.43	3.34	4.60	2.37	6.53	5.56	8.07	2.98	4.85	11.78	5.29	62.77
1885	3.94	7.65	9.03	5.82	9.70	1.61	3.24	5.29	2.30	9.25	12.48	5.24	75.55
1886	4.56	7.12	5.76	1.36	2.36	1.48	18.62	5.60	3.98	4.47	5.25	3.63	64.19
1887	6.89	1.60	3.19	3.81	9.45	4.67	2.64	5.08	2.65	2.17	6.73	5.50	54.38
1888	5.82	4.24	3.00	2.47	1.07	7.79	7.28	4.74	3.12	5.98	6.37	8.45	60.33
1889	7.40	6.51	4.43	11.09	13.13	2.32	5.76	4.05	4.64	6.99	1.35	3.90	71.57
1890	1.78	4.01	5.09	3.81	7.54	8.42	5.68	2.04	4.15	6.54	5.54	5.10	59.70
1891	4.07	4.73	7.19	5.60	5.81	5.57	3.25	13.75	8.15	9.72	5.04	0.80	73.68
1892	3.92	6.42	5.43	2.51	0.87	3.86	3.91	6.95	3.45	15.32	5.89	2.91	61.44
1893	6.07	1.73	7.90	2.13	5.95	8.62	3.77	4.35	2.56	1.99	4.09	3.76	52.92
1894	5.81	3.29	2.52	2.59	6.05	3.12	3.39	5.03	9.52	9.13	3.05	5.99	59.49
1895	3.52	5.39	5.49	6.07	2.45	6.97	6.67	2.45	7.88	6.40	3.51	5.75	62.55
1896	6.69	4.99	8.32	1.39	2.76	4.43	1.53	5.22	4.85	5.44	3.45	5.14	54.21
1897	4.42	2.21	2.11	5.80	4.15	7.84	4.94	7.97	3.51	6.82	1.19	3.62	54.58
1898	2.81	4.47	0.62	7.10	1.46	6.20	2.71	3.90	3.41	2.05	5.64	1.45	41.82
1899	5.20	2.80	3.56	5.79	4.20	3.40	6.93	5.38	11.09	1.39	6.82	4.76	61.32
1900	6.92	4.93	4.74	1.47	6.94	4.08	2.19	5.25	7.95	4.07	3.60	8.74	60.88
1901	9.44	4.87	7.82	6.45	1.33	1.63	2.08	1.62	1.37	9.85	7.04	2.09	55.59
1902	3.73	7.41	3.73	12.65	2.95	6.80	1.71	16.54	2.05	10.01	3.16	5.69	76.43
1903	3.37	1.79	3.35	4.54	3.88	4.35	2.05	2.96	7.80	6.26	3.87	6.32	50.54
1904	5.91	3.68	3.28	2.39	9.09	5.42	6.28	4.58	1.60	8.10	2.60	2.38	55.31
1905	3.18	3.20	1.74	6.80	6.16	4.92	5.32	6.38	2.52	5.20	5.50	9.64	60.56
1906	6.70	8.52	6.94	3.32	2.32	2.04	1.00	4.46	3.82	11.74	4.96	5.36	61.18
1907	1.48	5.76	1.58	4.82	3.88	4.82	2.24	3.16	3.34	7.02	1.76	5.48	45.34
1908	4.46	5.78	8.98	4.32	2.62	2.64	2.14	1.82	5.68	9.62	4.24	1.36	53.66
1909	5.16	4.26	4.94	2.06	3.82	2.12	7.46	5.82	15.00	7.66	5.22	5.44	68.96
1910	9.42	4.26	3.00	9.30	5.36	0.88	1.18	0.64	6.50	4.92	3.30	4.38	53.14
1911	1.78	1.18	2.40	1.72	2.82	6.14	1.66	7.24	2.94	1.40	7.00	3.28	39.56
1912	6.54	3.66	4.82	3.28	1.70	2.98	11.24	7.76	1.78	2.16	3.24	2.22	51.38
1913	2.20	5.90	3.34	1.94	1.32	2.10	2.22	8.86	1.84	4.22	11.36	3.68	48.98
1914	6.18	10.40	5.20	3.90	5.16	2.08	1.74	4.78	6.58	4.08	1.04	10.46	61.60
1915	2.84	3.52	6.70	2.36	1.82	10.98	4.37	4.79	16.13	1.33	2.90	2.85	60.59
1916	1.68	5.07	5.44	3.20	1.64	2.12	5.45	5.36	6.98	3.08	7.00	2.54	49.56
1917	3.32	2.56	1.92	1.88	4.18	6.08	3.00	4.82	7.94	17.42	3.06	6.84	63.02
1918	3.80	1.34	2.72	8.80	0.80	7.96	4.54	8.14	7.56	2.88	11.44	4.18	64.16
1919	6.56	3.60	2.17	4.64	2.36	2.82	0.84	6.92	5.62	2.51	4.28	6.52	48.84
1920	4.04	6.26	10.05	1.44	8.46	1.45	3.53	3.60	2.23	3.11	3.80	4.55	52.52
1921	5.99	5.54	1.36	2.57	8.07	2.59	1.50	4.75	4.09	5.03	6.27	6.67	54.43
1922	5.95	3.33	1.67	2.92	3.37	10.26	2.95	3.87	6.90	5.81	3.67	3.16	53.86
1923	4.40	3.23	4.71	4.05	5.14	1.62	2.27	2.40	4.40	5.18	5.31	2.52	45.23
1924	3.17	5.61	6.68	3.34	5.19	4.65	7.66	6.14	3.84	4.77	4.01	1.57	56.63
Means	4.48	4.60	4.74	4.10	4.54	4.49	4.53	5.40	5.19	5.95	5.01	4.78	57.80

TABLE 2.—*Average monthly and annual number of days with rainfall of 0.25 inch or more and 0.01 inch or more, Hamilton, Bermuda, 1897–1924*

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year
0.25 inch or more [1]	6	5	5	4	4	4	4	6	5	6	5	5	58
0.01 inch or more [2]	16	14	13	11	10	11	12	14	13	14	15	15	158

[1] Means derived by W. H. Potter from the original unpublished records.
[2] From the records of the Prospect Observatory as published in the Blue Books of the colony. This table is given "as the records were made, but it is apparent from the original records that all rainfalls under 0.02 inch were recorded as 'trace' in the earlier years, so the number of 'rainy days' is somewhat less than it should be."

TABLE 3.—*Amounts and averages, by months, of the greatest daily rainfall, Hamilton, Bermuda, 1897–1924*

[From the records of the Prospect Observatory as published in the Blue Books, supplemented by investigation of the original records]

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1897	0.82	1.11	0.65	2.46	1.32	2.42	2.20	2.15	0.90	2.50	0.41	1.62	2.50
1898	1.12	1.70	0.48	1.90	0.40	1.15	0.82	1.06	1.08	0.47	1.90	0.40	1.90
1899	1.30	0.72	0.92	1.46	1.15	2.50	3.35	1.10	3.73	0.75	3.54	2.26	3.73
1900	2.30	1.02	0.93	0.46	1.52	1.64	1.01	1.52	2.74	1.50	0.84	2.87	2.87
1901	3.02	1.45	4.80	2.37	0.42	0.44	0.80	0.37	0.22	2.41	1.52	0.67	4.80
1902	1.06	3.28	0.94	10.75	0.80	4.70	0.55	3.08	0.81	3.21	1.77	1.43	10.75
1903	0.65	0.71	1.02	1.50	2.17	1.68	1.02	1.01	4.55	1.70	1.18	1.00	4.55
1904	1.04	0.92	1.14	1.82	3.30	1.56	1.10	1.02	0.54	1.54	0.58	0.84	3.30
1905	0.50	0.70	0.64	3.12	3.90	2.06	1.04	1.20	0.96	1.70	0.72	4.64	4.64
1906	2.48	1.94	1.96	0.96	1.36	1.40	0.48	1.12	1.44	3.16	3.10	1.04	3.16
1907	0.54	1.12	0.62	1.80	1.04	1.52	1.20	0.86	0.78	2.16	0.64	1.38	2.16
1908	1.12	1.44	5.86	1.90	0.94	0.88	0.50	0.56	2.02	2.78	1.58	0.26	5.86
1909	3.16	1.46	0.88	0.86	0.92	0.80	1.74	2.90	6.58	2.90	1.20	0.78	6.58
1910	3.84	1.64	1.34	4.96	3.36	0.30	0.40	0.20	1.96	2.60	0.86	1.36	4.96
1911	0.48	0.30	0.50	0.96	1.48	1.56	0.44	1.94	1.62	0.78	2.44	1.24	2.44
1912	1.56	1.22	1.40	1.32	0.52	0.70	2.76	1.66	0.66	0.84	1.00	0.42	2.76
1913	0.56	1.16	0.86	0.56	0.72	0.66	0.78	2.72	0.76	1.04	3.62	1.08	3.62
1914	1.90	2.72	1.22	1.18	3.06	0.72	0.64	1.64	2.26	1.40	0.34	1.68	3.06
1915	1.00	0.80	1.56	0.88	0.48	2.38	2.89	2.61	6.06	0.42	0.93	0.59	6.06
1916	0.50	1.59	1.19	1.11	0.87	0.79	1.41	2.79	2.14	1.98	1.96	0.72	2.79
1917	1.36	0.74	0.44	0.66	1.20	2.08	1.70	0.76	2.46	5.04	0.80	1.24	5.04
1918	1.14	0.52	1.02	2.42	0.48	1.54	1.70	2.38	3.24	0.62	3.20	2.56	3.24
1919	1.22	0.58	0.44	1.16	1.72	0.82	0.32	1.64	1.36	0.86	0.82	0.98	1.72
1920	0.76	1.44	1.70	0.44	5.09	0.82	1.18	0.97	0.46	1.44	1.30	0.92	5.09
1921	2.50	3.30	1.03	1.16	5.50	0.80	0.70	1.64	0.94	2.04	1.98	1.90	5.50
1922	1.02	0.92	0.36	1.36	2.14	8.00	0.72	1.46	4.91	1.49	0.84	0.76	8.00
1923	1.10	0.98	0.91	1.14	2.29	1.36	0.86	0.72	1.79	2.28	1.00	1.50	2.29
1924	1.30	1.88	1.85	1.20	1.44	2.15	3.12	2.10	1.88	2.74	1.04	0.66	3.12
Means	1.41	1.33	1.31	1.85	1.77	1.69	1.27	1.54	2.10	1.87	1.47	1.31	4.16

NOTES, ABSTRACTS, AND REVIEWS

SOLAR-CONSTANT VALUES

Values of the solar constant were last published in this REVIEW for February, 1923.[1] Doctor Abbot has just issued a report under the title "Provisional Solar-Constant Values, August, 1920, to November, 1924,"[2] which brings the record of daily solar constant values down to the end of November, 1924. Doubtless a copy of the report can be supplied by Doctor Abbot, whose address is Smithsonian Institution, Washington, D. C.—EDITOR.

THE METEOROLOGICAL WORK OF THE "JACQUES-CARTIER"

By E. DELCAMBRE, National Meteorological Office of France

[Translated from *Comptes Rendus*, 179, No. 23, December 8, 1924, pp. 1337-1339, by B. M. Varney, Weather Bureau, Washington]

The Compagnie Générale Transatlantique and the National Meteorological Office of France, in cooperation, have organized and developed continuously since 1921 a special meteorological service on board of the *Jacques-Cartier*, school ship for the regular transatlantic service. The object of this note is to summarize briefly the principal results so far attained.

1. *The extension of the réseau of synoptic observations assembled by radio for purposes of forecasting on land.*—The uninterrupted reception on a continent, of the international observations made four times daily on shipboard during an entire Atlantic crossing, was realized in January 1923 from the *Jacques-Cartier* en route from Le Havre to New Orleans. In the eastern Atlantic, transmission to Brest is direct; in the western Atlantic or in the Pacific, a relay via Washington is necessary.

Still more important is the fact that the *Jacques-Cartier* is the first floating station for the assembling and retransmission to land, of the observations made on other ships. This organization is extremely useful because, first, most ships are equipped only with wireless sending apparatus which is too weak to permit of reaching the mainland unless the vessel is fairly close to the coast, second, the necessities of commercial traffic are usually incompatible with the difficulties and the loss of time

[1] Values of the solar constant, 1920–1922, by C. G. Abbot and colleagues. MO. WEA. REVIEW 51: 71–81.
[2] Smithsonian Misc. Coll. 77: No. 3.

involved in establishing shore connection. The activity of the *Jacques-Cartier* in this respect has been constantly increasing. During the return voyage of March–April 1924 (Vancouver to Bordeaux) she received 61 observations from French ships and 338 from foreign ships of all nationalities. Certain of these vessels kindly acted as relay stations for the picking up of observations of ships still more distant. On the Atlantic the observations received averaged some 30 per day.

This network of oceanic observations, of an extent and closeness hitherto unknown, reaches Paris simultaneously with the regular observation of the *Jacques-Cartier*, and France insures their being broadcast throughout Europe by incorporating them in the meteorological message sent from the Eiffel Tower.

Very recently (November, 1924) a still greater advance has been achieved by the use of very short wave lengths (115 meters). The meteorological messages from the *Jacques-Cartier* have been received at Paris directly, during a complete Atlantic crossing (Bordeaux to Panama), and even, at certain hours, when the ship was in the Pacific.

2. *The work of a floating station for the forecasting of ocean weather.*—In addition to the ship observations which it collects, the *Jacques-Cartier* has at its command the European and American meteorological radiograms received on board.[1] Charts, sometimes more correct over the ocean than over the land, can therefore be regularly drawn twice a day on board, a fact which allows the working up of weather forecasts *on the spot* (an enormous technical advantage) and the broadcasting of them by radio for the great trans-Atlantic routes. Westbound ships experience frequent and rapid changes of weather, and such forecasts have for them a special interest. In the case of the fast eastbound liners, they are not passed by more than one depression at most, even in winter. Hence it is sometimes possible to indicate for them, as early as the time of their leaving port, the broad characteristics of the weather changes for their whole voyage. The forecast service of the *Jacques-Cartier* has become steadily more popular at sea. Thus in bad weather it is not uncommon for vessels in the neighborhood to cease sending in order to listen to her message; and frequently special forecasts are asked for.

It is the value of these forecasts, based on the modern methods developed in France and Norway, which assures the growth of the *Jacques-Cartier's* "station" network, through its "clients" for the receipt of weather forecasts becoming its "purveyors" of observations.[2]

The forecast studies on board of the *Jacques-Cartier* have advanced our knowledge of dynamic meteorology. From these studies, the results of which will be presented in due time by their authors, Mm. Coyecque and Wehrlé, we may for the present draw two general fundamental conclusions: (1) The conception that the Atlantic Ocean acts as a barrier (écran) [to the passage of disturbances from North America to Europe], is no longer tenable; the progress of perturbations is continuous across the Atlantic. (2) The action of the polar front makes itself felt at times down to the region of the Equator; the trade winds are only approximately "permanent."

[1] The sending from the Eiffel Tower of messages on very short wave lengths permitted in November, 1924, the communication direct to the *Jacques-Cartier* of the meteorological situation over Europe during the entire Atlantic crossing.

[2] Mention should be made also of the hearty cooperation of the U. S. Weather Bureau in giving very efficient publicity to the work of the *Jacques-Cartier* through the medium of the Pilot Charts. [For two notes descriptive of the meteorological activities of the ship, see North Atlantic Pilot Chart for March, 1923, "Storm and Weather Forecasting on the Atlantic Ocean"; and for December, 1924, "Meteorological Service of the *Jacques-Cartier*." The bulletin of the National Research Council for January, 1924, pp. 100, 101, contains a note by E. H. Bowie on "The meteorological work of the *Jacques-Cartier*."—B. M. V.]

The success of the tests made by the *Jacques-Cartier* has demonstrated the possibility and the utility of a service which shall collect observations and make forecasts for the Atlantic area. Since 1923 the International Meteorological Committee has given its support and its official recognition to the project. The proper thing now is to organize this service definitely through international cooperation.

HATTERAS DEPRESSIONS

By M. COYECQUE and PH. WEHRLÉ, National Meteorological Office of France

[Translated from *Comptes Rendus*, 179, No. 26, December 29, 1924, pp. 1617–1620, by B. M. Varney, Weather Bureau, Washington]

1. *The facts, based on observations on board the "Jacques-Cartier."*—The region off Cape Hatteras distinctly constitutes a birthplace of atmospheric disturbances. A faint nucleus of barometric depression appears, at first almost stationary. It grows, accompanied by the development of a heavy A. St. Finally the Hatteras depression, with isobaric system fully formed, begins to move slowly toward the northeast, but does not reach normal velocity until it is opposite Nantucket Island. Opposite Newfoundland it turns definitely toward the east, thus getting into line with the series of polar LOWS (depressions along the polar front, properly so called), either merging with one of the latter or maintaining its own individuality. Hatteras depressions affect almost the whole of Europe, and at times extend into rather low latitudes. They are usually intense enough to cause gales from northeast around to northwest in American waters from Hatteras to Newfoundland. The storm connected with the Hatteras LOW may traverse the Atlantic (e.g., January 8, 1924).

The frequency of the Hatteras depressions is of the order of 20 per year. Their formation is almost entirely confined to the cold season. It always induces the movement, out of the north or northwest, of an intense high-pressure center with a complete anticyclonic circulation. The depression appears along the border zone, between the warm air current from the southwest directed by the Atlantic anticyclone and the cold current from the easterly sector controlled by the moving anticyclone.

The process may, however, develop somewhat differently, the depression being extremely weak (sometimes even lacking a cloud system), and moving slowly from the west to the region opposite Hatteras, where it begins rapidly to become more intense. A secondary Hatteras depression and even sometimes a tertiary of decreasing intensity, is sometimes related to the same high pressure center.

2. *Interpretation.*—The strong high-pressure center essentially represents an invasion of polar air,[1] and the formation of the Hatteras LOW is due to the contrast between the temperature of this air and that of the very warm tropical air above the Gulf Stream; hence the geographic localization. But in summer the polar air is warmed over the continent; hence the seasonal localization.

Two types of Hatteras depression should be recognized: (*a*) The LOW formed at the expense of the mother cyclone, which, as in the case of the April 19, 1922, cyclone, disappears. This type of Hatteras depression is characterized by the presence in its northern sector of a very clear line of discontinuity (thus forming an extra front resembling

[1] See J. Bjerknès and K. Solberg, The Evolution of Cyclones. Memoir of the National Meteorological Office of France, No. 6, 1924, pp. 95 ff.

that along the [true] cold front), but separating two masses of polar air [which formerly constituted the two currents on opposite sides of the cold front] of the parent cyclone, namely, the returning polar air from the east which is relatively mild, and the new polar air from the northwest, which is very cold.[2]

(*b*) The parent cyclone persists (case of January 17, 1922). The northern sector of the Hatteras LOW is then made up of a homogeneous mass of cold air. This condition of affairs, which is the most frequent condition, especially in winter, demands a powerful invasion of polar air, thus putting an end to the series of cyclones in the family.[3] Under these conditions several Hatteras LOWS are produced in succession. If the invasion is powerful enough it may even continue its progress toward the south and form (in autumn and spring) an "*Antillaise.*" [4]

The fact that the Hatteras depressions are young explains their lasting all the way across the Atlantic Ocean. Born at the end of a cyclone family, their trajectories in the nature of the case lie farther to the south, and they are able to come on shore in Europe at a lower latitude (unless the Azores anticyclone, by shifting toward the northeast, forces them nearer Iceland). Always if they unite with a polar LOW it is necessarily with the first member of the next succeeding family, and hence at a fairly high latitude.

In case where the original depression comes from the west, it seems to proceed from a California pseudofront resembling a Mediterranean pseudofront (the Pacific anticyclone being substituted for the Atlantic anticyclone), [5] or from a southern branch of the Pacific polar front, which divides by fission when it runs foul of a weak continental anticyclone.

3. *Contribution to general dynamic meteorology.*—The first type of Hatteras LOW is to be likened to the Genoese depressions. But in the case of the latter the cutting off of the warm sector (seclusion)[6] is accomplished only by the chain of the Alps; while in the case of the Hatteras depression it is the severed tropical "root" of the mother cyclone which is revitalized by the effect of the contrast in temperature, *whence we have a confirmation of the idea that the phenomena of regeneration of cyclones tend to favor certain regions.*

The second type is to be compared with the Mediterranean pseudofront. But in America, it is in winter that the low temperature of a mass of polar air crossing the continent is best retained, while for Morocco it is in summer, since the journey is an oceanic one. Furthermore, in America, in the absence of a center of action, the temporary invasion by a moving anticyclone can give birth to only an occasional disturbance. In contrast to this, in the eastern Atlantic a polar invasion reinforces a great anticyclonic *massif* along [the border of] which a persisting control can function. In any case *the building up of the polar front by the mechanism of wave formations operates preferably in regions where special seasonal controls favor a seasonal development of the phenomena.*

In view of the analogy between the great warm and cold currents in the western Pacific and the western Atlantic, it is not impossible that some of the polar LOWS of America have their origin over Japanese waters through a mechanism similar to that which causes the Hatteras depressions.

The Hatteras depressions may unite either with the polar LOW which comes immediately after their parent cyclone, or with the following LOW. They show (1) *the interference of well developed and intense depressions;* (2) *that a wave formation may unite with a depression belonging to the next succeeding cyclone family.*

[2] This situation will be made clear by reference to J. Bjerknès and H. Solberg, Life Cycle of Cyclones and the Polar-Front Theory of Atmospheric Circulation. Geofysiske Publikationer, 3, No. 1, Kristiania, 1922. See especially p. 10, the right-hand diagram of Figure 6.

See also the review and discussion of the above paper, by A. J. Henry in MO. WEATHER REV., September, 1922, **50:** 468–474. The Figure 6 cited above is reproduced on p. 470.

[3] J Bjerknès and H. Solberg, *loc, cit*, p. 91 ff.

[4] [This name, which has not, as yet, acquired standing in meteorological terminology, seems to be here applied to a northerly wind caused somewhat as the Texas "norther" is. Professor Talman suggests that it may be the "nortes" of the old Spanish navigators in the Antilles.—B. M. V.]

[5] See Ph. Schereschewsky and Ph. Wehrlé, Pseudo Polar Fronts. Comptes Rendus, 179, 1924, p. 1185.

[6] *Loc. cit.*, p. 1618.

METEOROLOGICAL SUMMARY FOR JANUARY, 1925, IN SOUTH AMERICA

[Reported by Señor Julio Bustos Navarrete, director El Salto Observatory, Santiago, Chile]

The month was relatively rainy in southern Chile, northern Argentina, and Bolivia. Cyclonic depressions were frequent in the southern part of the Continent; at Punta Arenas the pressure fell to 28.94 inches (735 mm.) on the 7th.

On the 21st an important anticyclonic center was situated off the Atlantic coast from Bahia Blanca and the mouth of the Rio Negro; the maximum pressure at this time was 30.32 inches (770 mm.).

In general, temperatures were rather high in central Chile and on the Atlantic coast. Maximum temperatures of 104° and 95° (40° C. and 35° C.) were recorded at Buenos Aires and Santiago, respectively. The lowest temperature observed was 29° (−1.6° C.) at Lonquimay in the Chilean Andes.

Electrical storms with rain and hail were rather frequent at La Paz and Sucre.

Director Navarrete submits two weather maps, one each for January 7 and 21. The first portrays a deep barometric depression centered over the extreme southern tip of the Continent with an area of high pressure over the Pacific just west of Chile. This is the type of cloudy, rainy weather in Chile.

The second map presents a different pressure distribution, viz, a strong anticyclone centered over the Atlantic coast east of Argentina. This is a type of fair weather with partial cloudiness in the central regions of Paraguay and Argentina.

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The following titles have been selected from the contents of the periodicals and serials recently received in the library of the Weather Bureau. The titles selected are of papers and other communications bearing on meteorology and cognate branches of science. This is not a complete index of all the journals from which it has been compiled. It shows only the articles that appear to the compiler likely to be of particular interest in connection with the work of the Weather Bureau.

Bell telephone quarterly. New York. v. 4. January, 1925.

Barrett, R. T. Mobilizing for the fight against sleet. p. 22–36.

Engineering news-record. New York. v. 94. January 29, 1925.

Church, J. E., Jr., & Jones, E. H. Precipitation and runoff at the Continental Divide. A discussion of the apparent disparity in precipitation and runoff, with an analysis of the data in the light of snow surveying. p. 190–195. [With a discussion by H. P. Boardman.]

France. Académie des sciences. Comptes rendus. Paris. t. 180. 5 janvier 1925.

Mariolopoulos, E. G. Sur des pluies observées parfois avec les anticyclones. p. 82–83.

Franklin institute. Journal. Philadelphia. v. 199. February, 1925.

Peek, F. W., Jr. Lightning. p. 141–182.

Great Britain. Meteorological office. British rainfall, 1923. London.

Glasspoole, John. Fluctuations of annual rainfall; a comparison of 35-year rainfall averages over the British Isles for different groups of 35 years falling in the period 1868 to 1921. p. 238–256.

Nature. London. v. 115. 1925.

Cloud forms. p. 30–31. (Jan. 3.) [Review of U. S. Weather Bureau's cloud chart.]
McLennan, J. C. On the luminescence of solid nitrogen and argon. p. 46–47. (Jan. 10.)

Nature magazine. Washington, D. C. v. 4. December, 1924.

Talman, Charles Fitzhugh. Winter's robes of white. p. 341–345.

Nature magazine. Washington, D. C. v. 5. 1925.

Talman, Charles Fitzhugh. The wonderworld of ice. p. 15–20. (Jan.).
Talman, Charles Fitzhugh. Explorations in cloudland. p. 95–99; 133. (Feb.).

North American almanac. Chicago. 1925.

Pinnacled snowfields. p. 65–66.

Physical review. Corning, N. Y. v. 25. January, 1925.

Loeb, Leonard B. A question as to the value of some evidence adduced by Nolan to prove the existence of groups of normal ions in air at atmospheric pressure. p. 101.

Physikalische Zeitschrift. Leipzig. 25. Jahrgang, no. 15. 1924.

Gockel, A. Bemerkungen zum täglichen und jährlichen Gang des Potentialgefalles und des luftelektrischen Vertikalstromes. p. 381–390.

Tichanowsky, J. J. Der Polychroïsmus der Himmelspolarisation. p. 390–391.

Revue d'optique théorique et instrumentale. Paris. 3 année. Novembre 1924.

Gorczynski, Ladislas. Sur un instrument thermo-électrique simple pour enregistrer l'intensité du rayonnement solaire. p. 473–487.

Revue générale des sciences. Paris. 35. année. 15 novembre 1924.

Mascart, Jean. Le climat primaire de la terre. p. 594–596.

Terrestrial magnetism and atmospheric electricity. Baltimore. v. 29. December, 1924.

Mauchly, S. J. The radium-emanation content of sea air from observations aboard the *Carnegie*, 1915–1921. p. 187–194.

Tycos-Rochester. Rochester, N. Y. v. 15. January, 1925.

A famous typhoon outlook in the Philippines. p. 31–32.

Flora, S. D. Taming the thunderbolt. p. 18–19.

Houk, Ivan E. When the thunderstorm approaches. p. 23–24.

McLoud, Norman C. Who says the weather man is always wrong? p. 12–15. [Repr. Pop. Sci. Mo.]

Olson, D. S. Snowslides. Some facts about their menace and their prevention. p. 5–7. [Repr. Sci. Amer.]

Talman, Charles Fitzhugh. Choosing a weather vane. p. 8–11.

Van Cleef, Eugene. Coming to blows with nature. p. 16–17.

U. S. Hydrographic office. Pilot chart of the North Atlantic ocean. Washington, D. C. March, 1925.

Smith, Edward H. The ice drift in the North Atlantic.

SOLAR OBSERVATIONS

SOLAR AND SKY RADIATION MEASUREMENTS

By HERBERT H. KIMBALL, In Charge, Solar Radiation Investigations

INSTRUMENTS AND EXPOSURES

In the MONTHLY WEATHER REVIEW for January, 1924, **52**:42, will be found references to descriptions of instruments and exposures, and an account of the method of obtaining and reducing the measurements. To the statement then made it should be added that thermoelectric recording pyrheliometer No. 8 was installed at the New York Meteorological Observatory, Central Park, New York City, on April 16, 1924. The receiver is placed on the parapet of the tower of the observatory, south of the wind vane and other instrumental supports, so that it is freely exposed to the sun from sunrise to sunset. The wind vane and support cut off a small fraction of the radiation from the northern sky, however.

The elevation of the receiver above sea level is 156 feet (48 meters), the latitude is 40° 46′ north, and the longitude 73° 58′ west. In winter, with light winds, the atmosphere over Central Park may become filled with rather dense smoke. In summer, and especially with a brisk west or north west wind, the smoke is light.

The normals from which are obtained the departures of the mean radiation values in Table 1 include the measurements for the current month, as heretofore. Those for Table 2 include measurements to the end of 1924 only. For Madison, for January to March, inclusive, they are based upon records covering 13 years, and for the remaining months, 14 years; for Washington, from January to October, 10 years, and for the remaining two months, 11 years; for Lincoln, the records generally cover 8 years, although there have been some interruptions. At Chicago and New York the records are too short to give reliable weekly normals.

MEASUREMENTS DURING JANUARY, 1924

From Table 1 it is seen that the departures are small and irregular at all three stations. Table 2 shows a deficiency in the incoming radiation, due to unusual cloudiness. No skylight polarization measurements of value were obtained at either Washington or Madison, as the ground was mostly covered with snow at both stations throughout the month.

TABLE 1.—*Solar radiation intensities during January, 1925*

[Gram-calories per minute per square centimeter of normal surface]

Date	8 a.m.	Sun's zenith distance									Noon
		78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	
	75th mer. time	Air mass									Local mean solar time
		A. M.					P. M.				
	e.	5.0	4.0	3.0	2.0	*1.0	2.0	3.0	4.0	5.0	e.
	mm.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*mm.*
Washington, D. C.											
Jan. 5	2.62	0.85		1.10	1.34			1.17	0.84	0.67	3.99
6	3.15					1.04	0.98	0.84	0.72	0.62	3.45
7	2.62	0.64	0.75	0.84	1.13						3.68
13	3.63							0.98			4.37
21	2.36			1.19	1.37	1.65	1.44	1.26	1.08	0.96	2.36
22	3.30				1.21						4.37
23	1.12					1.57	1.40	1.27	1.12	1.03	1.45
24	1.37				1.19						1.52
28	0.74	1.03	1.15	1.25	1.35	1.44	1.21	1.11	0.95	0.83	0.81
30	2.49	0.28	0.37	0.69	1.07		1.23				2.16
Means		**0.70**	**0.76**	**1.01**	**1.24**		**1.25**	**1.10**	**0.94**	**0.82**	
Departures		**−0.04**	**−0.08**	**+0.02**	**+0.01**		**+0.03**	**+0.07**	**+0.07**	**+0.04**	
Madison, Wis.											
Jan. 8	1.45		1.15	1.24							1.88
9	2.16							0.63			3.00
13	1.52		0.85	1.03							1.45
20	2.62							1.26	1.19		3.15
22	2.74				1.45						2.36
27	0.51	1.05	1.15	1.29		1.48					0.91
31	3.30				1.12						4.57
Means		**(1.05)**	**1.05**	**1.19**	**(1.28)**			**(0.94)**	**(1.19)**		
Departures		**+0.09**	**−0.03**	**−0.05**	**−0.08**			**−0.28**	**+0.06**		
Lincoln, Nebr.											
Jan. 5	2.49							1.29	1.16	1.01	2.87
6	2.36		0.99	1.09				1.23	1.11	0.84	3.15
8	1.88	0.73	0.80	0.98				1.10	1.02	0.85	2.26
12	1.52							1.28	1.03	0.89	1.45
13	1.32							1.08	0.90		1.96
17	1.07		1.02	1.15							1.96
19	2.62							1.18	0.97		3.00
20	3.45						1.45	1.28	1.14	1.03	2.26
Means		**(0.73)**	**0.94**	**1.07**			**(1.45)**	**1.21**	**1.05**	**0.92**	
Departures		**−0.18**	**−0.08**	**−0.10**			**+0.17**	**+0.02**	**+0.01**	**+0.01**	

* Extrapolated.

TABLE 2.—*Solar and sky radiation received on a horizontal surface*

[Gram-calories per square centimeter of horizontal surface]

Week beginning—	Average daily radiation					Average daily departure from normal		
	Washington	Madison	Lincoln	Chicago	New York	Washington	Madison	Lincoln
	cal.	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*	*cal.*
Jan. 1	152	111	202	56	87	−1	−31	+13
8	100	141	177	79	91	−59	−11	−22
15	144	176	214	81	102	−24	+9	+4
22	204	183	198	91	152	+25	−3	−30
Excess or deficiency since first of year on Jan. 28						−413	−252	−245

WEATHER OF NORTH AMERICA AND ADJACENT OCEANS

NORTH ATLANTIC OCEAN

By F. A. YOUNG

The following table shows the average sea-level pressure for the month at a number of land stations on the coast and islands of the North Atlantic. The readings are for 8 a. m., 75th meridian time, and the departures are only approximate, as the normals are taken from the Pilot Chart and are based on Greenwich mean noon observations, which correspond to those taken at 7 a. m., 75th meridian time.

Station	Average pressure	Departure
	Inches	*Inches*
St. Johns, Newfoundland	29.80	−0.09
Nantucket	30.15	+0.06
Hatteras	30.17	+0.04
Key West	30.09	−0.01
New Orleans	30.15	+0.03
Swan Island	29.97	−0.01
Turks Island	30.14	+0.09
Bermuda	30.23	+0.09
Horta, Azores	30.17	+0.07
Lerwick, Shetland Islands	29.81	+0.11
Valencia, Ireland	30.04	+0.14
London	30.25	+0.25

At Lerwick, while the monthly average was not greatly above the normal, the barometric readings on the first three days of the month were all below 29 inches. The monthly range was from 28.52 inches, on the 2d, to 30.78 inches on the 26th. At Horta the range was from 29.34 on the 13th to 30.64 on the 28th.

This is the fifth consecutive month on which the number of days with winds of gale force over the ocean as a whole exceeded the normal as shown on the Pilot Chart. There were few days on which unfavorable weather did not prevail over some part of the steamer lanes, the storm area at times extending as far south as the 30th parallel.

According to reports received, the number of days with fog was less than usual over the ocean as a whole, with the exception of the waters adjacent to the American coast between the 35th and 45th parallels, where it was observed on from three to eight days. Fog was also reported on three days in the western part of the Gulf of Mexico and on two days in the vicinity of the Bermudas.

The month began with a severe disturbance near the north coast of Scotland, and on the 1st and 2nd moderate to strongly westerly winds prevailed over the region between the 40th and 50th parallels, extending as far west as the 40th meridian.

Mr. R. Evans, second officer of the British S. S. *Menominee*, Captain Gallard, bound from London to Boston, reports:

> At 2 p. m. on January 2, in 45° 20′ N., 42° 30′ W., a tidal wave of great height was encountered from NW. by N., height about 45 feet.

On the 2nd a shallow depression was central near Hatteras. This moved slowly northeastward and on the 4th and 5th was over Newfoundland, although on these days moderate weather was the rule over the ocean as a whole. On the 2nd and 3rd heavy winds were encountered over a limited territory between Hatteras and Nantucket, and on the latter date northerly to northwesterly gales, accompanied by hail and snow, were reported from vessels between the 45th and 50th parallels and the 30th and 40th meridians.

On the 6th there was a second depression near Hatteras that deepened rapidly as it moved northeastward. Charts VIII to XI cover the period from the 7th to 10th, inclusive, and an examination of these and of the table of ocean gales and storms will give an idea of the extent and severity of this disturbance.

On the 12th and 13th there was a "double LOW" over the ocean. On the former date one center was near 40° N., 40° W., and the other near 50° N., 30° W. On the 13th the first LOW was central in the vicinity of the Azores, and the second at 50° N., 20° W. By the 14th they had apparently joined forces, and until the 17th an area of low pressure covered the region between Scotland and Iceland. This disturbance reached its greatest intensity on the 13th when practically the entire ocean north of the 30th parallel and east of the 45th meridian was swept by severe gales, accompanied by rain, hail, and snow. On the 12th there was a moderate depression off the American coast between Hatteras and the Virginia Capes. This moved northeastward, losing in intensity, reaching Nantucket on the 13th and St. Johns, Newfoundland, on the 14th. On the 12th moderate gales were encountered between the 35th and 40th parallels, and on the 14th in the vicinity of St. Johns.

On the 18th there was a disturbance of limited extent and intensity central near 47° N., 40° W., and on the same date unusually strong easterly trades prevailed between the Canal Zone and Jamaica.

On the 20th there was a moderately deep depression between Hatteras and New York, with northeasterly gales off the immediate coast. On the same date the middle section of the steamer lanes was swept by moderate to strong gales, the storm area extending as far south as the 35th parallel. On the 21st the western LOW was near 40° N., 53° W., and the conditions were similar to those of the previous day, except that the storm area had increased in extent, as gales were encountered over the greater part of the ocean between the 30th and 50th parallels, east of the 65th meridian.

On the 22nd the western disturbance was central near 42° N., 45° W., and some gales were reported from the area between the 35th and 45th parallels and the 35th and 50th meridians. Moderate westerly gales were also encountered between the 25th meridian and the coast of southern Europe.

On the 23d there were two LOWS over the ocean, the first central near the west coast of Newfoundland, and the second near 48° N., 30° W. Westerly to northwesterly gales prevailed over the region between the Bermudas and the 45th parallel, and reports of storms were received from vessels in the territory between the two disturbances and also in the eastern section of the steamer lanes.

The western LOW moved but little during the next 24 hours, and on the 24th the eastern disturbance was central near 50° N., 20° W. Northwesterly gales were reported along the American coast between Key West and Hatteras, and heavy weather also prevailed over the greater part of the ocean between the 30th and 50th parallels and the 20th and 60th meridians.

By the 25th the conditions had moderated over the greater part of the ocean, although gales were reported from vessels in the middle section of the steamer lanes.

On the 26th abnormally high pressure was recorded at land stations in northern Europe, while low pressure still prevailed in mid-ocean. From that date until the 30th moderate to strong gales were encountered over the middle and eastern sections of the steamer lanes, although the storm area varied considerably in extent from day to day.

On the 28th there was a moderate depression of limited extent a short distance north of Bermuda, and on that date and the 29th northerly to easterly gales prevailed along the American coast from Hatteras to Nantucket.

On the 30th Portland, Me., was near the center of a disturbance which gave moderate to strong gales between the 35th and 45th parallels, west of the 60th meridian.

On the 31st the center of the LOW was near St. Johns, Newfoundland, and the storm area had extended as far east as the 40th meridian.

Ocean gales and storms, January, 1925

Vessel	Voyage		Position at time of lowest barometer		Gale began—	Time of lowest barometer	Gale ended—	Lowest barometer	Direction of wind when gale began	Direction and force of wind at time of lowest barometer	Direction of wind when gale ended	Highest force of wind and direction	Shifts of wind near time of lowest barometer
	From—	To—	Latitude	Longitude									
North Atlantic Ocean			° ′	° ′				*Inches*					
Novian, Br. S. S.	New York	London	49 42 N.	11 28 W.	1st	2 a., 1st	1st	29.58	WSW.	SW., 8	W	SW., 11	WSW.-SW.-W.
Turcoman, Br. S. S.	Avonmouth	Portland, Me.	51 35 N.	13 46 W.	1st	4 a., 2d	3d	28.61	SSW.	S., 9	W	W., 9	SSW.-W.
San Jacinto, Am. S. S.	New York	Galveston	38 35 N.	74 20 W.	1st	2 a., 2d	10 p., 2d	29.80	N	E., 10	NE	ENE., 10	E.-ENE.
Lancaster, Am. S. S.	London	New York	36 35 N.	68 14 W.	6th	3 p., 6th	7th	29.58	SSE.	SW	NNW.	NW., 10	SW.-W.
Chester Valley, Am. S. S.	Galveston	Liverpool	38 40 N.	63 00 W.	6th	5 a., 7th	7th	28.70	W	NW., 10	NW	12	W.-NW.
Chifuku Maru, Jap. S. S.	Lisbon	Philadelphia	41 01 N.	53 41 W.	7th	2 p., 7th	10th	29.74	Var.	SW., 12	N	12	SW.-W.
Ala, Am. S. S.	New York	Rotterdam	45 30 N.	37 50 W.	7th	3 p., 8th	11th	28.97	SSE.	SW., 9	SSW.	SSE., 11	S.-SW.
Monticello, Am. S. S.	Hamburg	Philadelphia	50 55 N.	31 30 W.	8th	3 a., 9th	10th	28.96	SSE.	SW., 9	WSW.	S., 10	S.-SW.-WSW.
Wieldrecht, Du. S. S.	Houston	Antwerp	42 00 N.	46 00 W.	12th	8 a., 12th	12th	29.39	E	E., 11	N	E., 11	E.-N.
Mapia, Du. S. S.	Rotterdam	New Orleans	35 37 N.	39 22 W.	12th	4 p., 12th	14th	29.42	SSW.	W., 9	N	W., 10	SSW.-W.-N.
San Gil, Br. S. S.	Boston	Port Limon	36 06 N.	73 11 W.	11th	1 a., 12th	12th	29.71	E	E	W	E., 8	E.-SW.-W.
Lavada, Br. S. S.	Avonmouth	New Orleans	47 04 N.	19 26 W.	12th	Noon, 13th	13th	28.93	SSW.	SSW., 10	NW	SW., 11	S.-SW.
Dakotian, Br. S. S.	Liverpool	do	37 37 N.	37 23 W.	11th	8 p., 13th	13th	29.36	W	WNW	NNW.	WNW., 10	W.-NNW.
Hellig Olav, Dan. S. S.	Norway	New York	58 04 N.	20 25 W.	12th	2 a., 14th	16th	28.01	SSW.	NW., 8	WSW.	WNW., 9	SW.-W.-NW.
Manchester Merchant, Br. S. S.	Manchester	St. John, N. B.	46 56 N.	51 13 W.	14th	4 p., 14th	16th	29.29	SW	W	NNW.	9	SW.-W.
Caronia, Br. S. S.	Boston	Liverpool	46 40 N.	37 50 W.	14th	8 a., 15th	15th	29.47	S	S., 10	NW	11	S.-NW.-W.
Stockholm, Swed. S. S.	New York	Gothenburg	56 20 N.	27 00 W.	16th	17th	17th	28.68	ENE.	W	W	W., 12	S.-SW.
Hellig Olav, Dan. S. S.	Norway	New York	49 25 N.	48 00 W.	17th	2 a., 18th	20th	28.82	SSE.,,	SW., 8	WNW.	SE., 10	SE.-S.-WSW.
F. H. Hillman, Am. S. S.	England	Canal Zone	12 20 N.	76 54 W.	18th	4 p., 18th	18th	29.79	E	E., 8	E	E., 9	Steady.
Westphalia, Ger. S. S.	Hamburg	New York	40 06 N.	12 08 W.	20th	Noon, 20th	20th	29.64	E	E., 8	NW	NW., 11	
Am. Press, Am. S. S.	New Orleans	Liverpool	45 15 N.	42 20 W.	19th	Noon, 20th	21st	29.73	NW.	NW., 9	NNW.	11	NNW.-NW.
Innoko, Am. S. S.	Rotterdam	New York	42 08 N.	26 05 W.	19th	10 a., 20th	21st	29.60	SSW.	SW., 10	SW	10	SW.-NW.
Albert Ballin, Ger. S. S.	Southampton	do	49 30 N.	21 11 W.	20th	5 p., 20th	20th	29.36	SSE.	SSE., 11	SW	SSE., 11	SSE.-S.
Rotterdam, Du. S. S.	Rotterdam	do	42 25 N.	54 54 W.	21st	Noon, 21st	21st	29.06	E	E., 7	N	E., 10	E.-NNE.
Anniston City, Am. S. S.	Port Said	Boston	36 39 N.	39 00 W.	21st	Noon, 21st	23d	29.62	WSW.	SW., 3	NW	NW., 10	SW.-NW.
Westport, Am. S. S.	Copenhagen	do	58 50 N.	15 45 W.	19th	21st	21st	29.67	SE.	SSE., 10	Var.	SSE., 10	S.-SSE.
Liguria, Ger. S. S.	Hamburg	Philadelphia	50 00 N.	13 40 W.	21st	4 p., 21st	22d	29.57	S	S., 9	W	S., 9	S.-WSW.
Darian, Br. S. S.	Boston	Manchester	43 14 N.	47 05 W.	22d	5 a., 22d	22d	28.94	NW.	NW., 9	WNW.	10	E.-S.
Breedijk, Du. S. S.	Rotterdam	New York	41 36 N.	64 18 W.	23d	8 a., 23d	24th	29.47	WNW	WNW	N	NW., 9	
Zarembo, Am. S. S.	Bordeaux	do	34 22 N.	54 30 W.	22d	9 a., 23d	24th	29.63	SW.	SW., 9	WNW.	11	W.-WNW.
Clavarack, Am. S. S.	Hamburg	Pensacola	43 45 N.	21 40 W.	22d	4 p., 23d	24th	29.81	SW	S	W	9	S.-W.
Subatco, Am. S. S.	Pensacola	New York	31 10 N.	79 26 W.	23d	Noon, 23d	24th	30.32	NE.	NNE., 8	NE	NE., 9	NNE.-NE.
Albert Ballin, Ger. S. S.	Southampton	do	44 15 N.	50 01 W.	24th	5 a., 24th	25th	29.26	W	W., 9	WNW.	NW., 10	W.-NW.-WNW.
Higho, Am. S. S.	Hamburg	Norfolk	34 30 N.	46 14 W.	23d	2 p., 24th	24th	29.62	SSW.	WNW	WNW.	SSW., 10	SSW.-WNW.
Madoera, Du. S. S.	Galveston	Bremen	42 10 N.	32 07 W.	24th	10 a., 25th	25th	29.51	SW	S., 10	WNW.	S., 10	S.-SW.-WNW.
Saucon, Am. S. S.	Italy	New York	38 00 N.	72 20 W.	27th	8 p., 27th	28th	30.00	N	NNE., 7		NE., 9	NNE.-NE.
Bay State, Am. S. S.	Dundee	do	55 30 N.	33 02 W.	26th	8 a., 27th	28th	29.28	S	NW., 9	NNE.	10	SW.-NW.
Sac City, Am. S. S.	Rotterdam	Boston	48 58 N.	36 47 W.	28th	1 p., 28th	28th	29.68	SW	SW., 9	WNW.	SW., 9	SW.-W.
Anniston City, Am. S. S.	Port Said	do	42 28 N.	65 19 W.	29th	6 p., 29th	30th	29.06	S	10		10	
Bay State, Am. S. S.	Dundee	New York	51 40 N.	42 00 W.	29th	8 p., 29th	30th	29.86	NW.	NW., 10	WNW.	10	WNW.-NW.
Innoko, Am. S. S.	Rotterdam	do	40 35 N.	66 00 W.	30th	Noon, 30th	31st	29.56	SE.	WSW., 10	NW	10	S.-W.
Westport, Am. S. S.	Copenhagen	Boston	45 55 N.	55 20 W.	30th	30th	Feb. 1	29.38	SW	SW., 8	NW	NW., 10	
Missouri, Br. S. S.	Antwerp	do	46 30 N.	38 51 W.	31st	10 p., 31st	Feb. 1	29.56	SSW.	SSW., 11	NW	SSW., 11	SSW.-NW.
North Pacific Ocean													
Havana Maru, Jap. S. S.	Otaru, Japan	San Francisco.	44 53 N.	158 30 E.	1st	4a., 2d	2d	28.98	E	W., 8	NW	11	SE.-W.
Pres. Jefferson, Am. S. S.	Yokohama	Seattle	50 10 N.	140 W.	1st	8p., 1st	3d	29.49	WSW.	SW., 8	WSW.	W., 10	S.-SW.-WSW.
West Jessup, Am. S. S.	do	Portland, Oreg.	43 35 N.	161 E.	1st	4a., 2d	3d	29.09	WSW.	WSW., 11	WNW.	WNW., 11	
Talthybius, Br. S. S.	Victoria, B. C.	Yokohama	46 55 N.	166 06 E.	1st	4p., 2d	6th	28.87	WNW.	N., 8	NNW.	NW., 10	SE.-W.-N.
Toyooka Maru, Jap. S. S.	Yokohama	Victoria	49 02 N.	129 23 W.	2d	10p., 2d	3d	29.84	S	SE., 9	SW	SE., 9	SE.-W.
Havana Maru, Jap. S. S.	Otaru	San Francisco.	47 28 N.	173 25 W.	4th	10a., 6th	6th	29.37	ENE.	NNE., 6	SW	11	NNE.-W.
Can. Skirmisher, Br. S. S.	Panama	Vancouver	46 N.	125 27 W.	4th	7p., 4th	5th	29.87	W	W., 8	W	W., 8	WSW.-W.
Emp. of Aus., Br. S. S.	Vancouver	Yokohama	52 N.	163 45 W.	5th	2p., 8th	8th	29.30	W	SW., 10	W	WSW., 11	SW.-WSW.
Can. Winner, Br. S. S.	Shanghai	Vancouver	49 52 N.	172 20 W.	6th	Noon, 7th	9th	29.17	SSE.	SSW., 6	WSW.	WSW., 10	SSW.-WSW.
West Jessup, Am. S. S.	Yokohama	Portland	49 10 N.	162 10 W.	7th	Noon, 7th	9th	29.58	WSW.	S., 4	W	W., 10	S.-SSW.
Havana Maru, Jap. S. S.	Otaru	San Francisco.	44 29 N.	140 41 W.	11th	2p., 12th	13th	29.76	S	SSW	WNW.	11	SW.-WNW.
Elkton, Am. S. S.	San Pedro	Yokohama	32 16 N.	155 58 E.	11th	8a., 11th	15th	29.34	SW	W	NW	W., 9	
West O'Rowa, Am. S. S.	Portland	do	36 54 N.	143 07 E.	12th	3p., 12th	13th	29.66	NW		NNW.	NNW., 9	SW.-NW.
Hawaii Maru, Jap. S. S.	Yokohama	Victoria	50 15 N.	162 53 W.	12th	6p., 13th	15th	29.24	E	S	W	8	
S. C. T. Dodd, Am. S. S.	MarcusHook	San Francisco.	15 10 N.	94 W.	14th	4p	14th	29.78	NW.	NW., 7	NNE.	8	
Makaweli, Am. S. S.	Bellingham	Kahului, Hawaii.	46 11 N.	129 42 W.	17th	3p., 17th	19th	29.66	S	S., 8	S	S., 10	
Salina, Am. S. S.	Manila	San Francisco.	34 52 N.	156 43 E.	18th	2a., 19th	19th	29.48	NW.	WNW	WNW.	WNW., 10	None.
West Keats, Am. S. S.	Tsingtao	Portland	47 35 N.	145 15 W.	18th	2a., 19th	19th	29.20	ENE.	N., 8	W	N., 8	NNE.-NNW.
Dellwood, Am. S. S.	Seattle	Alaska	55 20 N.	131 38 W.	19th	8a	19th	28.84	E	SSE., 8	SW	SSE., 8	SE.-SW.
West Sequana, Am. S. S.	Hongkong	San Francisco.	34 40 N.	158 45 E.	18th	2a., 19th	20th	29.55	NW.	W., 8	WSW.	W., 8	NW.-W.
F. H. Hillman, Am. S. S.	Panama	Los Angeles	13 56 N.	94 32 W.	23d	2p	23d	29.90	NNW.	N	NE	N., 9	NNW.-N.
West Sequana, Am. S. S.	Hongkong	San Francisco.	38 51 N.	176 34 W.	23d	Noon, 23d	24th	29.20	SE.	SW., 10	WSW.	SW., 10	SW.-W.
Salina, Am. S. S.	Manila	do	37 N.	179 32 E.	23d	Noon, 23d	24th	29.13	SE.	S	W	SW., 11	SE.-S.
Emp. of Asia, Br. S. S.	Yokohama	Vancouver	49 03 N.	128 W.	25th	6p., 25th	26th	29.31	SE.	SE., 8	SSE	SE., 8	S.-SE.
Makena, Am. S. S.	Mukilteo, Wash.	Hilo	39 25 N.	136 46 W.	29th	10a	29th	29.80	W	WNW., 7	NW	NW., 8	2 pts. rt.
Sheaf Mead, Br. S. S.	Grays Harbor.	Yokohama	35 36 N.	173 40 W.	29th	11p., 29th	31st	29.12	ESE.	SSW., 7	NW	NW., 10	ESE.-WNW.
Tascalusa, Br. S. S.	Manila	San Francisco.	38 04 N.	176 E.	30th	4p., 30th	31st	28.86	SW	WSW., 10	WNW.	WSW., 10	Steady.

NORTH PACIFIC OCEAN

By WILLIS EDWIN HURD

The North Pacific Ocean, though roughened by high winds, yet exhibited no conditions of abnormal storminess during the month of January, 1925. The average wind velocity, however, along the northwestern coast of the United States, as well as along southeastern Alaska, was somewhat higher than the normal for January, and a maximum wind velocity of 80 miles an hour from the south occurred at North Head, Wash., on the 18th. Except for this wind of hurricane velocity, no gales exceeding 11 on the Beaufort scale have been noted in any vessel report yet received for the month. Rain, snow, and hail squalls were frequent over the northern routes, and fresh to whole gales were of daily occurrence over some part of the ocean north of the 30th parallel. Nevertheless, many vessels made trans-Pacific passages without encountering gales, while others seemed to meet with a succession of rough areas, almost from coast to coast.

Fog occurred occasionally along the northern and southern steamer tracks, but none was reported west of the 180th meridian, except for a single instance southeast of Taiwan. It occurred frequently down the American coast from Cape Mendocino to near Cape San Lucas, and at San Francisco this January was the foggiest on record. South of the Gulf of Tehuantepec fog occurred on the 8th and 10th.

The pressure situation was quite different from that of December, 1924, except in the Far East, where the Asiatic anticyclone continued to prevail along the coast. East of the 180th meridian the month opened with the great Pacific HIGH well developed between the Hawaiian Islands and the American Continent, fair weather and moderate winds prevailing generally over this whole area. To the northward toward the Aleutian LOW, cloudiness with snow squalls increased, the LOW being now well developed and central near Kodiak. Nearly similar conditions lasted throughout the first decade, except that the LOW oscillated considerably, with the center or centers variously located over the Aleutians and the Gulf of Alaska. During this period at least four disturbances were detached from the parent cyclone and entered the Canadian Northwest.

During the remainder of the month the HIGH fluctuated a great deal in position and intensity, though the center rarely left the ocean for the continent as it did in December. Its general region, moreover, was practically gale-free throughout the month. The LOW meanwhile was extraordinarily active over a large region. Several cyclones came into its western area, and no less than seven depressions, during the last two decades, moved from its center in the Gulf of Alaska into the American mainland.

From about the 21st to the 30th an active center of low pressure over mid-ocean caused moderate gales to storm winds between the 35th and 40th parallels and for some distance on either side of the 180th meridian. This cyclone had receded northward by the close of the month.

The following data for Dutch Harbor, Midway Island, and Honolulu are indicative of the barometric conditions in their respective neighborhoods:

The average 8 p. m. pressure at Dutch Harbor was 29.72 inches, or 0.01 inch above the normal. From the 9th until the 23d pressure was above normal, except on the 10th and 13th. On the 13th the lowest pressure of the month, 28.92 inches, occurred. It was followed on the 15th by the highest pressure, 30.34. During the period from the 8th to the 15th several violent barometric fluctuations took place. Kodiak to the eastward seems to have been very near the mean position for the month of the center of low pressure for the entire northern region, and readings there rarely equaled 30 inches. The minimum was 28.70 on the 1st.

At Midway Island the average 8 p. m. pressure was 29.96 inches, being 0.04 inch below the normal. The extremes were 30.24, on the 1st and 2nd, and 29.68, on the 25th. Here readings were above normal on the first 10 days and mostly below thereafter.

At Honolulu pressure was again high during January, the average—8 a. m. and 8 p. m.—being 30.05 inches, or 0.04 inch above the normal. Subnormal readings occurred only from the 11th to the 14th. The extremes were 30.16, on the 22d, and 29.80, on the 13th.

This January at Honolulu was the warmest on record, due largely to the extraordinarily high night temperatures. The extremes were 81° and 65°. The total rainfall was 1.58 inches, or 2.20 inches below the normal. The month was sunnier than usual. The prevailing wind direction was from the east, though the kona (southerly winds) blew during several afternoons. For the first 11 days the wind velocity averaged nearly 17 miles an hour, and during 9 of them the maximum velocity exceeded 25 miles. The highest velocity was 37 miles an hour from the east, on the 8th.

Along the greater part of the coast of the United States precipitation was mostly below normal and temperatures were generally above. But farther north the reverse was true, January being exceptionally cold at Juneau and snowfall exceptionally heavy—53.9 inches.

There is no evidence of tropical-storm development in the Far East. The only gale reports for the Tropics near the American coast were by vessels in the gulf south of Salina Cruz. These winds, of force 8 to 9, were observed on the 14th, 23d, and 24th.

For the ocean as a whole gales were not so widespread as during the previous month, owing to the fact that LOWS generally ran less far south. There was a slight increase in the number of days with high winds over the 10° square, the center of which is 40° N., 140° W., but elsewhere there was a decrease or little change.

Vessels reported gales of force 11 on the 2d in east longitudes and on the 6th, 8th, 13th, and 24th, in west, as indicated by the table.

NOTES

American S. S. *Dellwood*, Capt. Robert W. Shears, Observer J. A. Higgins, Seattle toward Alaska and return:

The gale of January 19 (in 55° 20′ N., 131° 38′ W.) commenced with ESE. wind, accompanied with heavy snow. At time of lowest barometer torrential rain, with no wind, occurred.

British S. S. *Sheaf Mead*, Capt. H. B. Rae, Observer W. H. Sculthorpe, Grays Harbor, Wash., toward Yokohama:

Noon January 31, in lat. 35° 34′ N., long. 174° 30′ W. The height of the waves was about 45 feet from the trough to the crest. Tried fuel oil over side from lee bow with very little effect. Vessel steaming slow with wind and sea on starboard quarter.

DETAILS OF THE WEATHER IN THE UNITED STATES

GENERAL CONDITIONS

ALFRED J. HENRY

Several outstanding features may be mentioned: First, the absence of pronounced and widespread cold waves; second, the heavy rains in east Gulf and Southeastern States and the resulting floods, and, finally, the continued dry weather west of the Rocky Mountains and in California. The usual details follow.

CYCLONES AND ANTICYCLONES

By W. P. DAY

The month of January was one of considerable activity, if such a condition can be measured by the number of cyclones and anticyclones charted. During this period 22 low-pressure areas and 16 high-pressure areas were observed, with others of minor importance. Beginning with the first day a stream of LOWS (5) passed through the southern Alaska region and along the northern border until the 8th, when the chain was broken by the intrusion of a HIGH from the Mackenzie Basin. Following this HIGH and its attendants from the same region, the path of the LOWS was shifted southward as far as the coast of Washington on the 13th. This stream was cut off by rising pressure on the Pacific coast. Then followed three more LOWS on the northern path, a period ending on the 21st, when high pressure, which had been developing over Alaska and the Canadian Northwest, spread southeastward into the United States. A larger installment of this cold air followed on the 25th and a third of somewhat lesser importance on the 31st. The warm currents of the LOWS broke through at the weak points north and south of these HIGHS.

FREE-AIR SUMMARY

By V. E. JAKL

It is apparent from Table 1 that the only appreciable free-air temperature departures at the aerological stations were recorded at and near the ground; elsewhere within the vertical extent of observations the average temperatures were about normal. The range of temperature with altitude showed the characteristics of continental regions in midwinter, i. e., a reversal or an absence of the usual lapse rate for a considerable height above the ground. Specifically, for the stations of record, this exception to the usual lapse rate is evidenced as a pronounced inversion in the first 1,000 meters above the ground at the northern stations, and an approximately isothermal state for the same depth of air column over the southern stations. Inasmuch as the averages and normals for the month are a composite of daily observations, many of which exhibit the usual fall in temperature with altitude, it is evident that a number of cases were recorded where the reversal of the altitude-temperature gradient occurred to a much more pronounced degree and to greater elevations than is shown by the averages. This was frequently the case during the month at the northern stations. Such inversions are sometimes caused by a wedgelike advance of a cold wave, as was shown in the free-air summary for December, 1924. In other cases they are the sequel to cold waves, being caused by a change to warmer that is more rapid aloft than below. The following examples taken from the records of Drexel and Ellendale illustrate the free-air march in temperature and wind direction in the declining phase of cold waves. The Ellendale record covers the period from the 14th to 17th, near the end of which a rather tenacious HIGH over the region of the Dakotas gave way to a vigorous LOW from Alberta. The Drexel record for the 26th–27th shows the conditions respectively in the front and rear of a fast-moving cold HIGH that swept over the station in about a day and was followed by a trough of low pressure.

Free-air conditions at Ellendale, N. Dak., January 14–17, 1925

Altitude, m. s. l.	14th		15th		16th		17th	
	Temperature	Wind direction	Temperature	Wind direction	Temperature	Wind direction	Temperature	Wind direction
Meters	° *C*		° *C*		° *C*		° *C*	
444 (surface)	−25.5	WNW.	−23.4	NE.	−18.5	SSW.	−19.0	SW.
500	−25.0	WNW.	−24.1	NE.	−19.5	SSW.	−16.5	WSW.
1,000	−20.1	NW.	−20.4	ENE.	−6.7	SW.	−5.0	NW.
1,500	−15.0	NW.	−14.9	E.	−7.9	SW.	−4.5	NW.
2,000	−18.0	WNW.					−8.0	NW.
3,000	−19.9	NW.					−15.2	WNW.
3,400	−21.3	NW.					−19.0	WNW.
4,000	−22.0	NW.						

Free-air conditions at Drexel, Nebr., January 26–27, 1925

Altitude, m. s. l.	26th		27th	
	Temperature	Wind direction	Temperature	Wind direction
Meters	° *C*		° *C.*	
396 (surface)	−21.1	N.	−21.3	ESE.
750	−24.6	NNE.	−15.1	S.
1,000	−20.9	NNE.	−13.6	S.
2,000	−14.1	NE.	−8.6	SSW.
2,500	−12.9	NE.	−9.6	SSW.
3,000	−15.0	NNE.	−11.0	SW.
4,000			−16.4	WSW.
5,700			−27.7	W.

The importance of snow covering as a factor in retarding the recovery of temperature on the ground after a cold period, with particular reference to the records of Ellendale on the 14th–17th, is discussed by the official in charge of that station in the following extract from his report:

> The effect a moderate snow covering on the ground has on the surface temperature is strongly manifested in the kite records of the evening of the 16th and the morning of the 17th. In each case a marked temperature inversion was present. While the flight of the 16th was comparatively low, the height of the inversion was reached at about 700 meters above ground. The flight of the 17th was much higher, and the height of the inversion was about 800 meters above ground. The lowest temperature recorded aloft in this flight was 3° C. higher than the minimum surface temperature for the day. By the end of the flight the top of the inversion had lowered to within 300 meters of the ground. These inversions are not uncommon during the winter months, but this particular record seems to show that a snow covering will retard if not wholly prevent the warming up of ground temperatures when other conditions are ripe for rising temperature. Usually when marked inversions are shown in morning flights and there is little or no snow on the ground the maximum surface temperature for that day equals or exceeds the maximum of the inversion, but in this case the surface maximum did not come within 2° C. of it.

Kite and pilot-balloon observations showed the vertical distribution of winds normal for the month, viz,

resultant winds increasing in force and westerly component with altitude. This distribution of wind resultants applied to all stations of the country east of the Rocky Mountains except Key West, where general southerly winds occurred. With the exception noted, resultant winds at 4,000 meters, as shown by pilot-balloon observations, were generally strong from the west, with, however, a slight northerly tendency at most stations. The steep latitudinal pressure gradients in the high altitudes, causing the strong west winds normal to these altitudes in midwinter, are naturally the result of the horizontal temperature differences, which are most sharply defined at this time of year. This is well illustrated in the records of mean temperature at Ellendale and Groesbeck, which represent the extremes of latitude over the region covered by our aerological reports. It will be noted that large differences in monthly temperatures between the two stations are shown up to the upper limit of record. Individual cases occur where these latitudinal differences in temperature, and consequently the wind velocities arising therefrom, are greater than shown in the averages or normals. An instance is cited for the 7th, when the temperature difference between Ellendale and Groesbeck varied from 26.4° C. a few hundred meters above the ground, to 22.2° C. at 2,500 meters. The effect of this temperature gradient on free-air wind velocity is definitely proved by the double theodolite observation at Drexel on the date mentioned, which showed a general westerly wind increasing with altitude from 3 meters per second on the ground to 47 meters per second at 6,000 meters.

In contradistinction to the average latitudinal gradients and corresponding wind directions and velocities aloft, is the condition shown by the record of kite and pilot-balloon observations of Broken Arrow on the 18th, viz, winds backing from northerly on the ground to southeast at 4,700 meters. Surface pressure was higher at Drexel (north of Broken Arrow) than it was at Broken Arrow, while the free-air temperature was about the same at the two stations to 4,000 meters' altitude. There was therefore a north to south pressure gradient from the ground up to and beyond 4,000 meters.

TABLE 1.—*Free-air temperatures, relative humidities, and vapor pressures during January, 1925*

TEMPERATURE (° C.)

Altitude, m. s. l. (m.)	Broken Arrow, Okla. (233m.)		Drexel, Nebr. (396m.)		Due West, S. C. (217m.)		Ellendale, N. Dak. (444m.)		Groesbeck, Tex. (141m.)		Royal Center, Ind. (225m.)	
	Mean	Departure from 7-yr. mean	Mean	Departure from 10-yr. mean	Mean	Departure from 4-yr. mean	Mean	Departure from 8-yr. mean	Mean	Departure from 7-yr. mean	Mean	Departure from 7-yr. mean
Surface	0.3	−3.3	−7.4	−1.2	6.2	−0.3	−12.1	−0.9	4.8	−3.0	−5.1	−1.1
250	0.3	−3.3			6.2	−0.2			5.0	−2.6	−5.2	−1.0
500	0.5	−2.6	−6.8	−0.6	6.1	+0.3	−12.0	−0.9	5.6	−1.6	−5.2	−0.1
750	1.3	−1.6	−4.8	+0.9	5.8	+0.4	−9.9	+0.5	6.4	−0.7	−4.4	+0.9
1,000	1.8	−1.1	−3.1	+1.6	5.6	+0.7	−7.6	+1.3	6.7	−0.6	−3.8	+1.4
1,250	2.0	−0.9	−2.7	+1.4	5.1	+0.8	−6.2	+1.7	6.7	−0.4	−3.8	+1.5
1,500	1.8	−0.8	−3.1	+1.1	4.6	+1.1	−6.5	+1.4	6.4	−0.2	−4.1	+1.5
2,000	0.3	−0.9	−4.9	+0.6	2.6	+0.9	−8.7	+0.7	4.4	−0.6	−5.7	+0.8
2,500	−2.5	−1.3	−7.4	+0.3	1.2	+1.3	−11.7	−0.1	2.1	−0.7	−8.2	+0.2
3,000	−5.2	−1.6	−9.9	+0.3	−1.0	+1.3	−14.7	−0.5	−0.2	−0.7	−11.4	−0.6
3,500	−7.3	−1.3	−12.3	+0.3	−3.6	+1.2	−17.4	−0.4	−2.9	−0.7	−15.1	−1.6
4,000	−10.2	−1.4	−15.7	−0.3			−19.8	−0.2	−5.2	−0.3		
4,500	−13.0	−1.3	−18.9	−0.4			−22.2	0.0	−7.3	+0.5		
5,000	−15.6	−1.1	−22.2	−0.4					−10.8	+0.5		

RELATIVE HUMIDITY (%)

Surface	79	+8	81	−1	74	+6	84	+2	80	+3	82	+3
250	79	+8			73	+6			76	+1	81	+3
500	73	+8	73	−5	66	+4	81	+1	67	−4	72	0
750	66	+6	60	−11	63	+4	73	0	64	−3	64	−3
1,000	58	+3	52	−13	59	+2	67	+1	60	−1	59	−3
1,250	52	+1	48	−13	56	+1	61	+1	54	−2	55	−2
1,500	48	+1	46	−12	48	−5	61	+3	48	−4	52	−2
2,000	43	+1	48	−8	46	−3	62	+5	42	−5	50	+1
2,500	44	+3	48	−7	39	−6	64	+7	39	−5	52	+2
3,000	47	+6	46	−9	37	−6	63	+6	32	−9	54	+3
3,500	50	+9	45	−8	35	−8	60	+6	28	−11	60	+4
4,000	58	+15	45	−7			57	+5	28	−9		
4,500	67	+19	45	−7			45	−10	27	−9		
5,000	67	+18	48	−5					27	−8		

VAPOR PRESSURE (*mb*)

Surface	4.97	−0.99	2.91	−0.42	7.23	+0.26	2.28	−0.10	7.12	−1.64	3.44	−0.45
250	4.94	−0.98			7.15	+0.27			6.85	−1.58	3.35	−0.44
500	4.61	−0.68	2.76	−0.43	6.65	+0.38	2.22	−0.12	6.20	−1.59	2.95	−0.36
750	4.33	−0.47	2.57	−0.35	6.33	+0.44	2.32	+0.13	6.26	−0.99	2.74	−0.26
1,000	3.83	−0.49	2.52	−0.25	5.87	+0.34	2.37	+0.23	6.04	−0.56	2.67	−0.08
1,250	3.38	−0.52	2.41	−0.21	5.28	+0.22	2.35	+0.27	5.35	−0.61	2.52	+0.02
1,500	2.99	−0.49	2.27	−0.19	4.48	−0.08	2.24	+0.27	4.30	−1.05	2.31	+0.03
2,000	2.36	−0.46	2.09	−0.06	3.66	−0.01	1.88	+0.16	3.22	−1.07	1.92	+0.03
2,500	2.00	−0.36	1.73	−0.07	2.65	−0.16	1.47	+0.06	2.54	−0.97	1.67	+0.03
3,000	1.83	−0.19	1.37	−0.13	1.95	−0.31	1.01	−0.08	1.77	−1.05	1.40	−0.02
3,500	1.67	−0.09	1.11	−0.09	1.69	−0.23	0.67	−0.09	1.33	−0.97	1.18	−0.08
4,000	1.56	+0.03	0.99	+0.04			0.53	0.00	1.16	−0.72		
4,500	1.46	+0.07	0.89	+0.13			0.35	−0.24	1.03	−0.59		
5,000	1.40	+0.09	0.88	+0.27					0.95	−0.44		

TABLE 2.—*Free-air resultant winds (m. p. s.) during January, 1925*

Altitude, m. s. l. (*meters*)	Broken Arrow, Okla. (233 meters)				Drexel, Nebr. (396 meters)				Due West, S. C. (217 meters)				Ellendale, N. Dak. (444 meters)				Groesbeck, Tex. (141 meters)				Royal Center, Ind. (225 meters)			
	Mean		7-year mean		Mean		10-year mean		Mean		4-year mean		Mean		8-year mean		Mean		7-year mean		Mean		7-year mean	
	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.	Dir.	Vel.
Surface	N. 55° W.	1.3	S. 44° W.	0.8	S. 79° W.	1.1	W	1.4	N. 40° E.	0.5	N. 71° W.	1.0	S. 84° W.	1.0	N. 59° W.	2.8	N. 35° W.	1.2	N. 34° W.	0.6	S. 6° W.	0.9	S. 49° W.	2.0
250	N. 62° W.	1.3	S. 41° W.	1.0					N. 38° E.	0.2	N. 80° W.	1.0					N. 51° W.	1.1	N. 67° W.	0.4	S. 20° W.	1.5	S. 49° W.	2.3
500	W	1.5	S. 31° W.	2.1	S. 81° W.	2.0	N. 85° W.	2.4	N. 44° W.	1.3	W	2.3	S. 62° W.	1.8	N. 63° W.	3.2	S. 77° W.	1.2	S. 56° W.	1.4	S. 54° W.	5.0	S. 58° W.	4.7
750	S. 71° W.	1.9	S. 36° W.	3.0	S. 81° W.	3.1	N. 79° W.	4.2	W	1.7	S. 84° W.	3.7	S. 76° W.	3.7	N. 68° W.	5.1	S. 65° W.	2.1	S. 61° W.	2.5	S. 69° W.	4.7	S. 66° W.	6.4
1,000	S. 76° W.	2.6	S. 50° W.	3.5	S. 77° W.	6.0	N. 79° W.	5.5	S. 65° W.	3.0	S. 81° W.	5.1	W	4.7	N. 64° W.	6.3	S. 69° W.	2.8	S. 63° W.	3.4	S. 69° W.	5.8	S. 74° W.	7.3
1,250	S. 84° W.	3.5	S. 68° W.	3.8	S. 76° W.	6.3	N. 78° W.	6.8	S. 82° W.	4.5	W	7.0	N. 77° W.	5.8	N. 64° W.	7.4	S. 67° W.	3.9	S. 71° W.	4.6	S. 81° W.	6.8	S. 79° W.	9.0
1,500	S. 79° W.	4.5	S. 67° W.	5.0	S. 84° W.	7.3	N. 75° W.	8.1	S. 85° W.	7.9	S. 85° W.	9.0	N. 77° W.	6.8	N. 65° W.	7.8	S. 65° W.	5.8	S. 74° W.	5.8	S. 86° W.	7.2	S. 83° W.	9.9
2,000	S. 85° W.	6.7	S. 79° W.	7.0	S. 84° W	8.6	N. 75° W.	10.4	W	11.4	S. 89° W.	12.0	N. 79° W.	10.5	N. 66° W.	10.5	S. 69° W.	7.8	S. 78° W.	7.5	S. 87° W.	9.6	S. 82° W.	11.9
2,500	S. 75° W.	8.5	S. 82° W.	8.5	S. 87° W.	10.9	N. 80° W.	12.5	S. 85° W.	13.1	W	14.8	N. 80° W.	13.7	N. 66° W.	12.8	S. 75° W.	9.4	S. 79° W.	8.8	S. 88° W.	10.4	S. 73° W.	14.2
3,000	S. 74° W.	9.7	W	9.6	N. 88° W.	12.4	N. 80° W.	14.2	S. 82° W.	16.1	S. 88° W.	16.4	N. 84° W.	12.5	N. 69° W.	14.1	S. 81° W.	10.0	S. 80° W.	10.1	S. 84° W.	13.8	S. 86° W.	14.2
3,500	S. 81° W.	8.2	N. 85° W.	9.7	S. 89° W.	14.4	N. 81° W.	15.4	S. 76° W.	18.4	S. 84° W.	16.6	N. 68° W.	16.6	N. 68° W.	15.3	S. 78° W.	12.4	S. 82° W.	11.4	N. 82° W.	15.1	S. 79° W.	13.4
4,000	S. 64° W.	7.9	S. 87° W.	10.9	N. 83° W.	16.6	N. 86° W.	17.0	S. 59° W.	22.0	S. 82° W.	16.1	N. 60° W.	17.9	N. 60° W.	16.9	S. 73° W.	13.1	S. 73° W.	12.6	N. 45° W.	14.0	S. 76° W.	15.2
4,500	S. 68° W.	9.1	S. 75° W.	9.6	N. 68° W.	21.0	N. 80° W.	17.8					W	18.0	N. 53° W.	19.0	S. 78° W.	13.8	S. 74° W.	14.2				
5,000	S. 68° W.	8.0	S. 85° W.	10.1	N. 68° W.	22.0	N. 78° W.	17.8									W	13.0	S. 88° W.	14.7				

THE WEATHER ELEMENTS

By P. C. DAY, In Charge of Division

PRESSURE AND WINDS

With the beginning of the new year the anticyclonic activity, that had been such a marked feature of the weather during the latter half of the closing month of 1924, became less pronounced in the more western districts, but continued with considerable reduction in frequency and extent over the Northeastern States. The local anticyclonic condition that existed over the eastern portion of the middle plateau during the latter half of December, notably in western Colorado and eastern Utah, continued at intervals throughout the month though not so persistently during the middle decade as in the first and last.

The new year opened with an important anticyclone attended by severe cold over New England and the Canadian Maritime Provinces which gradually moved to the northeastward and disappeared on the 3rd. About the 11th another high-pressure area developed northeast of the Great Lakes and moved rapidly toward the mouth of the St. Lawrence River, likewise attended by some sharp falls in temperature over the eastern Canadian Provinces and northeastern New England.

The last important anticyclone of the month moved southward from western Canada toward the United States on the morning of the 25th. By the following morning it had overspread the northern and portions of the middle Great Plains and thence northeasterly to the Lake Superior region and to portions of the Province of Ontario, with temperature falls of 20° to 40°, the line of zero temperature reaching southern Nebraska and that of freezing into northern Texas. As this anticyclone moved eastward during the following few days it was attended by the lowest temperatures of the month over nearly all districts from the Missouri Valley eastward.

The cyclones were confined mainly to the more southern and eastern districts, or to the more northerly course near the Canadian boundary. Those moving over the southern districts brought frequent precipitation, mostly rains, which were unusually heavy in the Gulf and South Atlantic States, particularly from the 8th to 12th and again from the 15th to 20th. The storms moving along the northern border usually gave only light precipitation, mainly snow.

The pressure as a whole was again above normal as in December, over the greater part of the country, particularly from the Great Lakes to New England, over the eastern Canadian Provinces and in the middle plateau region.

Compared with December, 1924, the average pressure was lower in all districts save from the Great Lakes eastward, and over California and the far Southwest.

The important winds of the month were confined to the Atlantic and Pacific coast districts and to only a few dates. Over the interior the winds were for the most part unusually light for the midwinter month.

The prevailing directions of the surface winds are shown on Chart VI.

TEMPERATURE

The month was practically free from intense cold waves ushering in widespread and prolonged periods of low temperatures, though there were a few cold waves of moderate importance, chiefly during the final decade. The greater part of the month was marked by persistent regional contrasts in the temperature conditions, some States or portions of States having lasting cold weather, while other near-by areas were experiencing rather mild weather for the season.

Until about the 20th, cold weather prevailed over most of the middle and southern Plains and the Southwest, without any important breaks. From northern Arizona northward and northeastward to about the 42nd parallel this abnormal cold was especially pronounced and the ground was deeply covered with snow over most of this area.

The Lake region and the Northeast likewise had cold weather, though it did not last so steadily as in the areas previously mentioned. Meantime in the Southeast temperatures were almost always above normal, particularly in Florida; and slightly above normal also from Minnesota westward to the North Pacific coast.

The final decade was marked by two cold waves, the earlier being felt chiefly in the Northeast, but the later extending over most of the eastern half of the country. At the same time decided warmth for midwinter prevailed in most western districts, especially from the upper Missouri Valley westward to the Cascade Mountains.

The closing days were marked by some rapid changes in temperature in many portions, but were mainly mild in the western half and cold in the eastern.

The lowest temperatures occurred chiefly during the middle decade in the western third of the country, at various dates in the middle and northern Plains, but almost always on the 27th or later in the southern Plains and over the eastern half of the country. The lowest temperature reported, −48°, occurred in extreme northern Maine. From Minnesota to Montana and in the elevated portions of the Western States the lowest marks of the month were not particularly low for midwinter. On the other hand, the readings about the 28th in the middle Ohio Valley and to eastward and northeastward were at many points among the lowest of local record.

The highest temperatures occurred usually about the 24th or 25th from New Mexico and Texas northeastward to the middle Mississippi Valley and in many middle Atlantic districts. Elsewhere in the eastern half of the country they usually came about the 6th to 10th. In the western half, except as previously mentioned, they occurred usually on one of the last three days of the month, but in the North Pacific States about the 20th.

The month averaged considerably warmer than normal in Florida and from North Dakota westward to Puget Sound, and usually a little warmer than normal in California, Nevada, Idaho, and Wyoming, also near the Mississippi River, in the western Lake region, and in the Ohio Valley and the districts south of it. There was a deficiency in the mean temperature in nearly all other districts, notably from Texas to Nebraska and thence westward to Utah and northern Arizona, and from Pennsylvania northeastward.

For large portions of Colorado this was the coldest or very nearly the coldest month of record while in some northern portions of New York and New England the deficiency averaged from 5° to 8° per day.

In southern Florida the month was warmer than normal throughout save during the last three days. In fact from December 15 to January 29 inclusive, 46 days, the temperature was continuously above normal, constituting the longest midwinter period of continued warmth of record in that locality.

PRECIPITATION

Viewed as a whole the month was one of scanty precipitation. The only considerable regions where the monthly totals were appreciably above normal were the southeastern, south-central, and east-central parts and the far Northwest. In the latter the excesses were moderate, but from eastern Louisiana to New Jersey there was a marked excess, especially from central Alabama to central South Carolina. In Georgia the month brought one-fourth more rain to the State as a whole than any previous winter month of record, while in Alabama and South Carolina it was decidedly the wettest January. The average amount in Georgia was 10.84 inches, but in the central division 12.29 inches. The chief periods of heavy rains in this area were the 8th to 12th and the 15th to 20th. Severe floods followed these heavy rains, the details of which appear elsewhere in this issue.

There was a considerable deficiency of precipitation in Arkansas, Tennessee, and the western portions of North Carolina and Virginia and in the States to the northward, but the consequences were seldom serious. Dubuque, Iowa, had quite, and Springfield, Ill., very nearly the least total precipitation of any January since records began.

In the northern border States there was usually less than the normal precipitation, except from Montana to the North Pacific coast, where there was a slight excess.

In California and Arizona the shortage was serious; southern California had especially little, and in Arizona the unusual shortage resulted in the practical exhaustion of the water supply in many grazing areas.

SNOWFALL

This was comparatively heavy in northeastern sections, particularly from western Pennsylvania to northern New England. The heaviest snowstorm over this region came during the closing days, when a strip from central Pennsylvania to northwestern Vermont received from 15 to 36 or more inches, the station at Syracuse, N. Y., recording 28 inches within 40 hours.

Near the middle Atlantic and New England coasts there was not so much snow at this time, the heaviest fall occurring either very early or about the 20th. In large portions of Maryland and northern Virginia the ground was snow-covered throughout the month, a rather unusual occurrence.

In North Carolina and to the westward and northwestward as far as or slightly beyond the Mississippi River, snowfall was less than the average for January and in the upper Lake region usually a little less than average, but in western Missouri and most of the middle Plains somewhat more than the average.

In the elevated districts of New Mexico, Colorado, Arizona, and California the snowfall was usually less than normal; also in Nevada, except the northeast portion. The North Pacific States, Idaho, and northwestern Montana had usually more than normal. In Utah and Wyoming the new snowfall of January was mainly light, but unusually large portions of those States were snow-covered, particularly during the first half, as a result of December snowfall.

The outlook for the summer water supply in the far West is comparatively good in most northern districts and fair in central, but poor in most Southern States. In practically all of California it is especially poor, though not quite so bad as a year ago at this time.

RELATIVE HUMIDITY AND SUNSHINE

The relative humidity values throughout the country were in the main slightly above normal, except in the far Southwest, where they were materially below. They were less than normal also locally in the far Northwest and generally over the lower Lake region and portions of the Ohio Valley.

Over the Southeastern States, despite the excessive precipitation, the relative humidity was only moderately high.

SUNSHINE

Cloudy weather persisted to an unusual extent in the Southeastern States, sunshine being scarcely one-third the possible amount. Similar conditions existed in the far Northwest and in the Great Lakes region, but this is not unusual for a midwinter month.

In most other parts of the country the sunshine was about what is usually experienced in January.

SEVERE LOCAL HAIL AND WIND STORMS, JANUARY, 1925

[The table herewith contains such data as have been received concerning severe local storms that occurred during the month. A more complete statement will appear in the Annual Report of the Chief of Bureau]

Place	Date	Time	Width of path (yards)	Loss of life	Value of property destroyed	Character of storm	Remarks	Authority
Middle Atlantic States	1-2					Snow and sleet	Street-car and railway service demoralized	Official, U. S. Weather Bureau.
Enterprise, Ala. (3 miles south of).	10	8 a. m.				Small tornado	Amount of damage not reported	Do.
West Elba, Ala	10	Noon				do	Small amount of damage	Do.
Shellhorn, Ala	10	do				do	Small amount of damage. In the above tornadoes several persons were injured and a few buildings demolished.	Do.
Barnwell, S. C	16	1:30 p. m.			$3,000	Probably thunderstorm.	Buildings and shade trees damaged.	Do.
Pendroy, Mont. (near)	18	10:30 a. m.	880		1,730	High wind	Buildings on two ranches damaged; also feed and seed barley.	Do.
New Jersey	20					Sleet	Motor traffic impeded or totally stopped in northern section.	Do.
New England	20					Snow and wind	No severe damage reported	Do.
Central New York	29-30			3		Snow	Arteries of travel generally in bad condition, causing traffic delay; scores of roofs caved in; schools closed; traffic tied up or delayed; 30 inches of snow in 24 hours.	Official, U. S. Weather Bureau; Journal News (Ithaca, N. Y.).
New England	29-30					Snow and wind	Motor and street-car traffic demoralized in some sections; railway schedules seriously delayed.	Official, U. S. Weather Bureau.

STORMS AND WEATHER WARNINGS

WASHINGTON FORECAST DISTRICT

A disturbance that was central off the North Carolina coast on the morning of the 1st, remained nearly stationary for 24 hours and then advanced north-northwest to a position immediately off the New Jersey coast on the evening of the 2nd. It thence moved slowly north-northeast to Nova Scotia by the morning of the 4th. Advices were disseminated on the 1st for strong northeast winds off the Middle Atlantic coast and on the morning of the 2nd northeast storm warnings were ordered for the Atlantic coast from Delaware Breakwater to Boston and at 3 p. m. of that date southeast warnings were extended to Eastport, Me. Strong winds and gales attended this disturbance.

On the evening of the 7th southwest storm warnings were ordered from Delaware Breakwater to Nantucket in connection with a disturbance of moderate intensity that was over Hudson Bay, but winds were only fresh to strong.

Northeast warnings were ordered from Delaware Breakwater to Boston on the afternoon of the 10th; but winds did not attain high velocities, and the warnings were ordered down the following morning.

In the morning radio bulletin of the 11th forecasts of strong winds were disseminated for the middle and north Atlantic coast. These were repeated on the 12th and the 13th, and strong winds and gales occurred as indicated.

Advisory warnings were issued on the afternoon of the 16th in connection with a disturbance over Georgia, but the disturbance did not increase in intensity as anticipated and dangerous winds did not result.

A disturbance that was off the South Atlantic coast on the evening of the 19th advanced rapidly north-northeast with greatly increased intensity to Massachusetts during the next 24 hours. On the evening of the 19th information was disseminated for increasing winds north of Sandy Hook and on the following morning northeast storm warnings were ordered from Delaware Breakwater to Eastport. Strong winds and gales occurred from Delaware Breakwater northward.

A disturbance of moderate intensity was over eastern Ontario on the evening of the 21st and advisory warnings were issued between Delaware Breakwater and Nantucket; further advices were disseminated on the morning of the 22nd and on the evening of that date northwest warnings were ordered displayed. Strong winds and gales occurred substantially as indicated.

Northwest storm warnings were ordered on the evening of the 26th on the Atlantic coast north of Delaware Breakwater and on the following afternoon they were changed to northeast. The strong winds and gales on the North Atlantic coast occurred substantially as indicated in the advices.

With a disturbance of increasing intensity over the North Carolina coast on the morning of the 29th, northeast storm warnings were ordered for the Atlantic coast from Delaware Breakwater to Nantucket and in the afternoon extended to Eastport. On the morning of the 30th the warnings were changed to northwest from Sandy Hook to Eastport. The winds and gales that followed were fully covered in the advices.

Frost warnings were issued for southern Alabama and southern Mississippi on the 12th, for portions of the South Atlantic and east Gulf States and Florida on the following morning and again on the 14th. The first two were verified, but cloudiness prevented the occurrence on the 14th.

Frost warnings were again issued on the 20th, but were only partially verified on account of cloudiness.

On the 29th frost warnings were issued for Alabama, Mississippi, and northwest Florida and on the 30th for Georgia, Alabama, and portions of Florida. Frosts occurred substantially as indicated, except that frosts occurred in Georgia and extreme northern Florida on the 30th that were not predicted.

On the 26th cold-wave warnings were ordered for the lower Lake region, the Ohio valley and portions of the east Gulf and Atlantic States and marked changes to colder weather occurred as indicated.—*R. H. Weightman.*

CHICAGO FORECAST DISTRICT

In the Chicago forecast district, January, 1925, was not a severe month, when contrasted with past months of the same name. In fact, there was much pleasant weather for the time of year; and especially was this true in the Northwestern States, particularly in Montana and Wyoming. Cold waves occurred with more or less frequency in the last two decades, but, as a rule, they were neither widespread nor of long duration.

Cold-wave warnings.—These were issued for some portion of the district on 15 days, but except in two cases, the warnings were for more or less limited areas. The most important cold wave was that covering the 25th to 27th, inclusive, and it affected virtually the entire district. Temperatures of from 20° to 30° below zero were reached at this time in most of North Dakota and northern Minnesota, while in portions of lower Michigan values were within a few degrees of the lowest of record for January. The warnings disseminated in this connection were well verified, but earlier action should have been taken for some north-central areas. Again on the 30th and 31st quite general warnings were issued for the northern and eastern portions of the district, but these failed of verification in western Montana, Illinois, Indiana, northern Missouri, and a few contiguous areas. Evidently, too much weight was given to the indications of the barometer-change map and not enough to Map "A."

Storms on Lake Michigan.—No severe storms affected Lake Michigan, where navigation continues to some extent throughout the winter months. However, strong winds occurred on a few days, reaching moderate gale force over portions of the lake once or twice. Advisory warnings were issued on the 6th, 20th, 21st, 25th and 31st.

Livestock warnings.—The month was favorable for livestock interests, and but one warning was issued in this connection; namely, that on the 15th for Nebraska, western Kansas and southern Wyoming.

Special forecasts.—On the morning of the date preceding the recent solar eclipse a special forecast of probable sky conditions along and near the path of totality in this district was made, the forecast calling for mostly cloudy weather. The ensuing conditions were as expected.—*C. A. Donnel.*

NEW ORLEANS FORECAST DISTRICT

Cold-wave and livestock warnings were issued for the northwestern portion of the district on the morning of the 15th, and extended at night over the interior of east Texas and northern Louisiana. The warnings were extended on the morning of the 16th over the remainder of the district. The cold wave occurred as forecast over

Oklahoma and the interior of Texas, but a slower movement of the disturbance in front of the high-pressure area retarded the fall in temperature over Louisiana, Arkansas, and the southeastern portion of East Texas.

Cold-wave and livestock warnings were issued on the morning of the 25th for Oklahoma and the northwestern portion of Texas and were extended over the district on the night of the 25th and during the 26th. Snow warnings were issued for the northern portion of the district. A severe cold wave overspread the district during the 26th and 27th and snow fell over the northern portion.

No cold wave occurred without warning. Timely warnings were issued for freezing near the coast.

Storm warnings were displayed on the Texas coast on the 16th and 26th, and small-craft warnings on the Louisiana coast on the 27th, and winds occurred which justified the warnings. No general storm occurred on the coast without warning.—*I. M. Cline.*

DENVER FORECAST DISTRICT

A storm attended by general precipitation advanced from the North Pacific coast southeastward across the Rocky Mountain Plateau to the west Gulf sections during the period from the 13th to the 16th; and a more moderate LOW, accompanied by light though general snow or rain, moved eastward from northern California to Wyoming and thence southward and southeastward during the 24th–26th. Throughout about all of the remainder of the month high pressures prevailed over the middle and southern plateau sections, with a succession of disturbances passing to the northward and eastward of the district, and precipitation in appreciable amounts was infrequent, except in northwestern Utah. Temperatures were generally much below normal until the 18th, with especially cold weather on the western slope of Colorado, which continued until the 23d.

Cold-wave warnings, which as a rule were verified, were issued as follows: 15th, moderate cold wave in western Colorado, northern New Mexico, northern Arizona, and southern Utah; 21st, moderate cold wave in southeastern Arizona; 25th, moderate cold wave in southeastern Colorado and extreme eastern New Mexico; 26th, moderate cold wave in southeastern New Mexico and eastern and central Arizona; 28th, severe cold wave in eastern and central Colorado, and a moderate cold wave in extreme eastern New Mexico.

On the 14th, when snow, probably heavy, followed by much colder weather, was forecast, advices were issued to livestock interests in western Colorado, northwestern New Mexico, northeastern Arizona, and southeastern Utah. The warning was verified. On the 28th, when light snow, with a severe cold wave, was indicated, the same interests in eastern Colorado were advised. The warning was only partly verified.

Frost warnings which were generally justified were issued for southern Arizona on the 1st and 2d; for south-central and southeastern Arizona on the 3d; south-central Arizona on the 4th, and extreme southwestern Arizona on the 7th, 10th, 12th, 14th, 17th, 19th, 21st, and 26th.

Warnings of freezing temperature, which also were generally verified, were issued for Arizona as follows: Southeastern, on the 4th; southern, on the 11th, 15th, 16th, and 18th; south-central and southeastern, on the 12th, 14th, 17th, 21st, and 26th.—*J. M. Sherier.*

SAN FRANCISCO FORECAST DISTRICT

The month was characterized by frequent rains over the Pacific Northwestern States and by deficient rains over California and Nevada. The rains over the northern portion of this district were attendant on the frequent and in most instances shallow depressions that crossed the coast line north of the mouth of the Columbia River. These averaged approximately fifteen in number, or one every other day, and after moving inland passed eastward, and rarely brought the southern part of this forecast district under their influence. This resulted in an increased deficit in the seasonal rainfall for California and Nevada.

In California at the end of the month the season of rains was half over, and the rainfall was then below normal for the season except in the San Francisco Bay region. The following table for regular Weather Bureau stations gives the precipitation for the season to date, the normal seasonal precipitation to date, and the seasonal rainfall for the preceding season to the same date:

Stations	Seasonal rainfall to date	Normal rainfall to date	Seasonal rainfall to date last year
	Inches	*Inches*	*Inches*
Eureka	22.59	24.52	13.88
Red Bluff	11.04	14.02	8.46
Sacramento	8.30	10.81	4.44
San Francisco	13.48	12.63	6.06
San Jose	5.72	9.10	3.63
Fresno	3.93	5.15	1.50
San Luis Obispo	6.69	10.50	3.33
Los Angeles	3.05	8.05	1.79
San Diego	2.32	5.17	2.48

Much apprehension is felt concerning the probable shortage of precipitation during the current season, following two years of deficient rainfall and snowfall. The fact that on a number of occasions when isobaric types that usually portend rain generally over the State passed eastward without appreciable rainfall, adds to the feeling of apprehension that the latter half of the season of rains will not likely bring the precipitation for the season up to normal. The deficit in rainfall for the season is notable over the southern part of the State, where it generally is less than during the preceding season.

The district forecaster was called on to forecast snows on a number of dates for the interior of the States of Washington and Oregon and for Idaho. Storm warnings were displayed on a number of dates for sections of the coast north of the San Francisco Bay region, and the majority of these were followed by winds of gale force, except on the Puget Sound, where the topography is such that rarely do the gales commonly experienced on the coast extend over this inland body of water. No cold-wave warnings were ordered, but warnings of frosts and freezing temperature were issued on a number of days during the first half of the month for the interior of California. The frost-warning service in the citrus regions of the southern part of the State was carried on in a very efficient and effective manner during a season calling for frequent firings to protect fruit and trees. The damage in orchards not protected has been considerable, while in the orchards that were properly fired the loss of fruit was inconsiderable.—*E. H. Bowie.*

RIVERS AND FLOODS

By H. C. FRANKENFIELD

There were no floods during the month of January, except in the rivers of the South Atlantic and east Gulf systems, but in these the floods were marked. In the Apalachicola and Altamaha systems of Georgia and Florida the river stages exceeded any previous records and the floods were attended by loss of life and the destruction of a great amount of property. A detailed discussion of these floods would be interesting, but in the interest of economy of space the details will be summarized in a brief general description, with the usual table of statistics following at the end of this report.

There were two flood periods in the rivers of the Carolinas. The first was a moderate one resulting from some heavy rains during December 31, 1924, and January 1, 1925, but before the rivers could recede to normal conditions, a second period of heavy rains set in, beginning January 9 and continuing until January 19 with, however, an intermission of three days from January 13 to 15, inclusive. The rainfall for this period is shown in the table immediately following:

Rainfall in inches, January 9 to 20, inclusive, 1925

River and station	Dates										Total
	9	10	11	12	13	16	17	18	19	20	
Roanoke:											
Randolph, Va.		0.78	1.25	1.15	0.05	0.12	0.35	0.03		0.45	4.18
Weldon, N. C.	T.	T.	0.48	1.18	0.78		0.46	0.53	0.14	1.13	4.70
Tar:											
Rocky Mount, N. C.		0.64	1.22	0.67			0.59	0.36	0.12	1.25	4.85
Tarboro, N. C.	0.02	0.58	1.27	0.50	T.		0.65	0.26	0.12	1.00	4.40
Greenville, N. C.		0.75	1.31	0.62			0.57		0.38	1.07	4.70
Neuse:											
Neuse, N. C.		0.35	1.06	0.92	0.04		0.72	0.60	0.12	1.04	4.85
Smithfield, N. C.	0.03	0.76	0.92	0.41	0.02		0.80		0.58	1.10	4.62
Cape Fear:											
Fayetteville, N. C.		1.15	1.10	0.58			0.94	0.18	0.53	1.01	5.49
Elizabethtown, N. C.		0.12	1.32	0.68			0.86	0.40	1.08	0.98	5.44
Haw:											
Moncure, N. C.	T.	0.58	0.47	0.59	0.01		0.78	0.54	0.35	1.00	4.32
Waccamaw:											
Conway, S. C.	0.18	0.10	0.90	0.61		0.13	1.76	0.55	1.18	0.35	5.76
Peedee:											
Cheraw, S. C.		0.58	1.63	0.12			1.32	0.42	0.82	0.83	5.72
Mars Bluff, S. C.		0.20	1.00	0.40			1.47	0.60	1.87	1.22	6.76
Lynches:											
Effingham, S. C.		0.15	1.25	0.57		0.16	1.80	0.85	1.50	1.20	7.48
Black:											
Kingstree, S. C.	0.15	0.05	1.70	0.20			1.80	0.50	1.75	0.70	6.85
Catawba:											
Mount Holly, N. C.	T.	0.78	0.84	1.86		0.22	1.00	0.48	0.74	0.74	6.66
Catawba, S. C.	T.	1.25	0.85	0.45			1.13	0.61	0.51	0.91	5.71
Wateree:											
Camden, S. C.	0.10	0.37	2.05	1.30	0.05	0.25	1.55	1.33	1.25	2.50	10.75
Broad:											
Blairs, S. C.	0.05	0.64	0.86	0.51		0.20	1.28	0.88	1.31	1.24	6.97
Saluda:											
Pelzer, S. C.	0.32	1.62	2.02	0.64		0.22	1.04	1.06	0.96	0.74	8.62
Chappels, S. C.		0.47	1.60	0.23		0.55	1.25	1.15	1.12	1.16	7.53
Congaree:											
Columbia, S. C.	0.03	0.21	1.37	0.85		0.58	1.48	1.18	1.38	2.37	9.45
Santee:											
Rimini, S. C.		0.15	1.10	0.65		0.65	1.45	1.90	2.15	1.85	9.90
Ferguson, S. C.	0.32	0.13	0.81	1.01		0.33	2.04	0.87	1.13	0.96	7.60
Broad:											
Carlton, Ga.	0.35	0.48	1.40	0.40		0.45	1.88	2.75	1.10	0.50	9.31
Savannah:											
Calhoun Falls, S. C.	0.06	0.48	1.32	0.36	0.06	0.76	1.56	1.89	1.00	0.54	8.03
Augusta, Ga.	0.02	0.08	1.79	0.57		0.41	2.53	2.25	1.95	1.89	11.49
Oconee:											
Milledgeville, Ga.	0.05	0.38	3.19			1.60	1.93	2.87	1.94	0.30	12.26
Dublin, Ga.	0.19	0.69	2.97	0.43		1.05	2.44	0.43	3.56	1.45	13.21
Ocmulgee:											
Macon, Ga.	0.16	0.60	3.28	0.17		1.65	2.06	2.97	1.95	0.06	12.90
Hawkinsville, Ga.	0.07	1.38	4.52	0.57		1.80	2.75	0.83	3.35	0.53	15.80
Abbeville, Ga.	0.04		3.75	0.25		0.85	1.75	0.16	2.25	1.48	10.53
Lumber City, Ga.	0.30		0.75	0.35		0.80	0.55	0.65	2.15	1.75	7.30
Flint:											
Woodbury, Ga.	0.20	0.28	2.10			3.20	0.90	2.80	1.00		10.48
Montezuma, Ga.	0.19	0.96	5.22	0.48		1.05	1.94	1.06	1.67	0.17	12.74
Albany, Ga.	0.35	0.01	4.30	0.45		0.41	1.75	0.90	3.05	0.36	11.58
Bainbridge, Ga.	0.66		0.35	0.31				0.02	2.45	0.48	4.27
Chattahoochee:											
Norcross, Ga.	0.55	1.06	2.92	0.23		0.95	0.77	2.82	1.01	0.17	10.48
West Point, Ga.	0.46	0.62	2.58			3.57	0.76	2.79	0.62	0.17	11.57
Columbus, Ga.	0.13	0.44	4.55	0.06		2.80	2.18	1.52	1.54	0.12	13.34
Eufaula, Ala.	0.30	3.62	3.38			2.24	2.10	2.95	2.16	0.10	16.85
Alaga, Ala.	0.07		1.59			0.26	2.23	1.46	1.61		7.22

Rainfall in inches, January 9 to 20, inclusive, 1925—Continued

River and station	Dates										Total
	9	10	11	12	13	16	17	18	19	20	
Apalachicola:											
Blountstown, Fla.	2.00		0.57	(1)	(1)	(1)	(1)	(1)	2.50		
Etowah:											
Canton, Ga.	0.97	0.98	1.59	0.12		0.67	0.82	2.65	1.04	0.19	9.03
Oostanaula:											
Resaca, Ga.	0.96	1.20	0.75	0.10	0.03	0.60	T.	1.45	1.00	0.40	6.49
Rome, Ga.	T.	1.89	0.82	0.60	0.10	0.79	0.51	2.20	1.11	0.30	8.32
Coosa:											
Gadsden, Ala.	1.79	0.76	0.97			0.70	0.63	1.77	1.07	0.30	7.99
Lock No. 4, Lincoln, Ala.	0.65	0.62				1.04	2.01	1.37	0.04		5.73
Wetumpka, Ala.	0.30	0.90	2.05			2.00	0.40	2.05	0.80	0.25	8.75
Tallapoosa:											
Milstead, Ala.	0.15	1.35	1.80			4.40	0.50	1.75	0.65	0.12	10.72
Cahaba:											
Centerville, Ala.	0.13	0.39	0.88	0.02		1.66	1.47	5.24	0.51	0.02	10.32
Alabama:											
Montgomery, Ala.	0.30	0.96	1.77	T.		4.32	0.86	2.41	1.04	0.15	11.81
Selma, Ala.	0.30	0.39	1.72	0.04		3.40	0.48	2.97	0.95		10.25
Black Warrior:											
Lock No. 10 Tuscaloosa, Ala.	0.73	0.45	0.62			1.10	0.50	2.29	0.78	0.02	6.49
Tombigbee:											
Columbus, Miss.	3.10	2.49	0.65			0.52	1.80	1.90	0.45	T.	10.91
Lock No. 4, Demopolis, Ala.	0.26	1.20	1.52	0.05		2.20	0.67	3.20	0.33		9.43
Chickasawhay:											
Enterprise, Miss.	1.12	1.36	0.36			2.00	1.23	2.52			8.59
Shubuta, Miss.	1.05	1.00	1.10			2.25	1.30	2.90	0.10		9.70
Leaf:											
Hattiesburg, Miss.	0.02	1.12	1.70			4.80	1.52	2.25	0.07		11.48
Pascagoula:											
Merrill, Miss.		0.56	0.86			3.72	1.04	3.66	0.22		10.06
Pearl:											
Edinburg, Miss.	0.17	2.06	0.83			1.04	1.65	2.28	0.18		8.21
Jackson, Miss.	0.20	2.50	0.95			1.45	1.35	1.50			7.95
Monticello, Miss.	0.30	1.23	1.82			4.68	1.95	4.06			14.04
Columbia, Miss.	0.10	0.66	1.12			5.51	0.96	2.78			11.13
Bogue Chitto:											
Franklinton, La.		0.92	1.53			2.85	1.70	1.70			8.70
West Pearl:											
Pearl River, La.		0.42	1.28			3.54	0.62	1.40	0.06		7.32

T=Trace of precipitation.

(1) Incomplete.

The inevitable result of such a protracted period of heavy rains was floods that affected the entire South Atlantic and east Gulf drainage areas except the Florida Peninsula, and the region of maximum flood occurrence closely coincided with the region of heaviest rainfall, namely central and southern Georgia and southern Alabama. In the rivers of North Carolina and eastern South Carolina the floods were relatively not severe, with the Cape Fear floods in the forefront.

The floods in the Santee and Savannah River systems attained somewhat greater proportions with a corresponding increase in loss and damage. No definite figures were received for the Savannah River, but the lowlands were overflowed on the South Carolina side of the river, submerging railroad properties, business establishments, and small houses, and the operation of cotton and other mills, and railroad traffic was suspended for a few days. The crest stage at Augusta, Ga., on January 20, 36.5 feet, or 4.5 feet above the flood stage, with the present levee, was equal to a stage of about 35.6 feet without levee protection, a fact that must be taken into consideration in computing flood crests for the swamps and lowlands below Augusta.

The floods in the rivers of the Altamaha system were the greatest of record and the losses and damage were of every imaginable character. Lumber, livestock, bridges, railroad tracks, and houses were carried downstream. Levees were broken; lumber, brick, and stock yards were overflowed, highways covered, and traffic of all kinds completely demoralized. In Telfair County it was reported that virtually all bridges were covered by the raging waters. At Milledgeville, Ga., on the Oconee River, the crest stage of 36.7 feet on January 19 was 14.7

feet above flood stage and 2.9 feet above the previous high water of March 17, 1912, while at Macon, Ga., on the Ocmulgee River the crest of 27.5 feet on the same date was 9.5 feet above the flood stage and 2.2 feet above the previous record of December 11, 1919. Similar reports were received from all other stations on these two rivers and from the Altamaha River which carried their combined flow. The automobile highway between Brunswick and Darien, Ga., across the 5-mile delta of the Altamaha River, was covered by water from 3 to 4 feet in depth. Over an area 15 miles in width many towns were completely surrounded by water, 500 or 600 people were marooned for days, and thousands of cattle sheep, and hogs were drowned in the low flat country.

In the Flint, Chattahoochee, and Apalachicola Rivers conditions similar in character prevailed, but in the Flint River, at least, they were in intensified form, the second flood closely following the first. Enormous areas of lowlands in central and southern Georgia and portions of northwestern Florida were covered with water, causing excessive damage of every description and total demoralization of industry. The town of Newton, Ga., the county seat of Baker County, on the lower Flint River, was completely submerged, and other towns and villages were surrounded by water for days, necessitating relief by the American Red Cross. In the Flint River below Montezuma, Ga., the crest stages were several feet higher than ever before, with the greatest excess of 5 feet at Bainbridge, Ga., near the mouth of the river. In the Chattahoochee the crest stages, while very high, were not unprecedented except in the vicinity of Alaga, Ala., where there was a slight increase over the previous high-water mark. In the Apalachicola River, however, which is the confluent stream, the crest stages were from 4 to 7 feet higher than ever before recorded.

The floods in the upper Coosa River and its tributaries were not severe, but in the lower Coosa and the Tallapoosa and in the Alabama, the confluent stream, the crest stages were from 7 to more than 18 feet above the flood stage, the excess occurring in the Alabama River. However, the high stages were several feet below extreme high-water marks.

There was a moderate flood in the Black Warrior River of Alabama and in the Tombigbee River at and below the mouth of the Black Warrior, with resulting overflow of river bottoms but without great loss of property.

The floods in the Pascagoula and Pearl system of Mississippi were also moderate, although the losses were rather heavier than in the State of Alabama.

Warnings of all these floods were issued as soon as the first reports of heavy rains were received, and continued daily and sometimes more frequently until the waters began to subside, and it is gratifying to state that over all the area covered by the flood waters there were only two casualties, two young men having been drowned while boating on Flint River in the vicinity of Albany, Ga. It has been impossible to obtain anything more than very rough and incomplete estimates of the amount of loss and damage and of the amount of property saved through the flood warnings. Such figures as were obtainable are given in the table below:

Statement of losses by floods and savings through warnings

[Not including figures for railroad property and highways]

State	Losses			Savings through warnings
	Miscellaneous	Crops and livestock	Suspension of business	
North Carolina	$25,000		$35,000	$30,000
South Carolina	213,250	$12,865	63,060	281,925
Georgia (Altamaha)	1,750,000	750,000		
Georgia (Apalachicola system)	367,000	15,000	50,000	300,000
Georgia-Alabama (Alabama)	18,975	4,980	3,590	49,000
Alabama (Tombigbee)	10,000	4,730		33,700
Mississippi	57,750	30,000	53,000	39,000
Total	2,441,975	817,575	204,650	733,625
Grand total of losses		3,464,200		

It will be seen from the above table that by far the greatest losses occurred in the drainage area of the Altamaha system, and it should be stated also that the table does not include losses over the Savannah drainage area and to railroads generally. In addition many observers reported the saving of thousands of head of cattle which were driven from the lowlands onto higher ground upon receipt of the flood warnings, and no value has been placed upon these.

Expressions of commendation from the press, commercial organizations, corporations, and individuals were numerous, and were appreciative as well of the saving of life and property as of the accuracy of the flood warnings. Under date of January 26, 1925, the Montgomery, Ala., Advertiser stated:

> It has been estimated by a prominent State official that special efforts of the local weather bureau in assembling data and issuing warnings during the recent flood crisis, were the means of saving $1,000,000 to citizens in river territories of middle and south Alabama.

Letters from commercial and other organizations were equally commendatory.

At the close of the month flood conditions were developing in the Willamette River of Oregon and report thereon will be made in the MONTHLY WEATHER REVIEW for February, 1925.

River and station	Flood stage	Above flood stages—dates		Crest	
		From—	To—	Stage	Date
ATLANTIC DRAINAGE					
Roanoke:	*Feet*			*Feet*	
Randolph, Va.	21	12	13	23.3	13
Weldon, N. C.	30	2	4	34.7	3
		12	16	40.0	14
Tar:					
Rocky Mount, N. C.	9	13	15	9.5	14
		21	22	9.0	21, 22
Tarboro, N. C.	18	14	19	21.3	17
		21	27	20.9	24
Greenville, N. C.	14	14	28	16.0	18
Neuse:					
Neuse, N. C.	15	2	4	16.8	4
		11	16	18.0	14
		19	23	16.8	20, 22
Smithfield, N. C.	14	2	6	16.3	5
		12	25	18.1	14, 22
Cape Fear:					
Fayetteville, N. C.	35	2	2	36.5	2
		12	14	42.1	13
		20	23	43.9	21
Elizabethtown, N. C.	22	2	5	28.0	3
		12	26	31.8	22

River and station	Flood stage	Above flood stages—dates		Crest	
		From—	To—	Stage	Date
ATLANTIC DRAINAGE—continued					
	Feet			*Feet*	
Haw: Moncure, N. C.	22	12	12	22.9	12
Waccamaw: Conway, S. C.	7	20	(1)	9.3	30,31
Peedee:					
Cheraw, S. C.	27	2	3	31.0	3
		12	14	34.0	13
		19	26	34.9	21
Mars Bluff, S. C.	17	3	11	20.2	7
		14	30	23.2	25
Lynches: Effingham, S. C.	14	18	28	17.1	21,24
Black: Kingstree, S. C.	12	17	28	15.1	21,22
Santee:					
Rimini, S. C.	12	(2)	(1)	23.8	23
Ferguson, S. C.	12	(2)	(1)	17.1	24
Catawba: Catawba, S. C.	12	20	20	12.5	20
Wateree: Camden, S. C.	24	12	14	27.5	13
		19	22	31.0	20
Congaree: Columbia, S. C.	15	2	2	16.0	2
		12	13	18.5	12
		18	22	23.5	20
Broad: Blairs, S. C.	15	1	2	17.5	1
		11	14	19.9	12
		18	21	20.9	20
Saluda:					
Pelzer, S. C.	7	1	1	7.0	1
		11	13	8.2	12
		18	21	8.8	20
Chappells, S. C.	14	1	3	16.5	2
		11	14	18.9	13
		17	23	20.5	20
Savannah: Augusta, Ga.	32	12	12	32.2	12
		18	21	36.5	20
Broad: Carlton, Ga.	11	12	12	16.0	11
		18	20	17.0	18
Oconee:					
Milledgeville, Ga.	22	1	1	22.9	1
		11	13	29.3	12
		17	23	36.7	19
Dublin, Ga.	22	14	15	23.4	14
		18	25	29.8	21
Ocmulgee:					
Macon, Ga.	18	11	13	19.8	11
		17	22	27.5	19
Hawkinsville, Ga.	29	19	24	36.7	20
Abbeville, Ga.	11	4	(1)	20.3	23
Lumber City, Ga.	15	16	(1)	26.0	21
EAST GULF DRAINAGE					
Apalachicola:					
River Junction, Fla.	15	4	4	15.0	4
		12	(1)	32.1	24
Blountstown, Fla.	20	14	----------	27.9	27
Flint:					
Woodbury, Ga.	10	17	21	16.7	19
Montezuma, Ga.	20	19	23	25.0	20
Albany, Ga.	20	13	29	36.6	21
Bainbridge, Ga.	25	15	(1)	[3] 39.6	24
Chattahoochee:					
West Point, Ga.	20	17	20	24.6	18
Columbus, Ga.	20	----------	----------	45.6	[4] 19
Eufaula, Ala.	40	12	13	43.0	12
		17	23	[4] 59.8	20
Alaga, Ala.	30	12	25	44.5	21
Alabama:					
Montgomery, Ala.	35	17	26	53.4	20
Selma, Ala.	35	17	28	53.6	22, 23
Tallapoosa:					
Milstead, Ala.	40	17	20	47.0	19
Coosa:					
Gadsden, Ala.	22	20	24	23.4	21, 22
Lock No. 4, Lincoln, Ala.	17	18	26	19.7	20
Wetumpka, Ala.	45	18	23	52.9	19
Etowah: Canton, Ga.	11	18	19	13.8	19
Cahaba: Centerville, Ala.	25	17	19	29.1	18
Tombigbee: Lock No. 4, Demopolis, Ala.	39	16	29	53.0	25
Black Warrior: Lock No. 10, Tuscaloosa, Ala.	46	18	21	54.7	19
Pascagoula: Merrill, Miss.	20	19	25	21.5	21
Chickasawhay:					
Enterprise, Miss.	21	18	21	29.6	19
Shubuta, Miss.	27	20	24	32.6	22
Leaf: Hattiesburg, Miss.	19	18	21	21.3	20
Pearl:					
Edinburg, Miss.	21	21	22	21.0	21, 22
Jackson, Miss.	20	18	30	28.8	25
Monticello, Miss.	18	18	22	21.6	18
Columbia, Miss.	18	17	25	23.7	20
Bogue Chitto: Franklinton, La.	16	18	19	18.8	18
West Pearl: Pearl River, La.	13	19	(1)	17.1	21
Holston, North Fork: Mendota, Va.	8	1	(1)	8.0	1
		12	12	9.0	12
PACIFIC DRAINAGE					
Willamette:					
Eugene, Oreg.	12	(2)	(5)	14.0	Dec. 30
Oregon City, Oreg.	12	31	(1)		
Santiam: Jefferson, Oreg.	10	30	31	11.8	30

[1] Continued at end of month.
[2] Continued from last month.
[3] Estimated.
[4] Probably too high.
[5] Below flood stage at 8 a. m., Jan. 1, 1925.

MEAN LAKE LEVELS DURING JANUARY, 1925

By UNITED STATES LAKE SURVEY

[Detroit, Mich., February 4, 1925]

The following data are reported in the "Notice to Mariners" of the above date:

Data	Lakes [1]			
	Superior	Michigan and Huron	Erie	Ontario
Mean level during January, 1925:	*Feet*	*Feet*	*Feet*	*Feet*
Above mean sea level at New York	601.12	578.24	570.62	244.22
Above or below—				
Mean stage of December, 1924	−0.30	−0.24	−0.16	−0.36
Mean stage of January, 1924	−0.48	−0.34	−0.65	−0.55
Average stage for January, last 10 years	−0.91	−1.51	−0.94	−0.98
Highest recorded January stage	−1.66	−4.43	−2.93	−3.38
Lowest recorded January stage	+0.24	−0.34	−0.34	+0.42
Average relation of the January level to—				
December level	----------	(2)	−0.1	(2)
February level	----------	(2)	+0.1	(2)

[1] Lake St. Clair's level: In January, 1925, 573.04 feet.
[2] Practically no difference.

EFFECT OF WEATHER ON CROPS AND FARMING OPERATIONS, JANUARY, 1925

By J. B. KINCER

General summary.—In the Southeastern States, the first and middle parts of the month were unfavorable for farm work because of frequent rainfall, and soon after the middle excessive rains occurred in parts of this area which caused flooding of lowlands and washing of fields. The high waters were especially bad in central and southern Georgia where there was much damage to truck crops. Considerable plowing was accomplished in the west Gulf section, and during the latter part of the month the warmer weather and generally lighter precipitation permitted much outdoor work in Central and Northern States.

A good snow cover was present during most of the month over much of the principal wheat-producing area, which was generally favorable for grains and grass, but at the same time the snow-covered range was rather unfavorable for stock interests in many grazing districts of the West.

Small grains.—The weather of January was generally favorable for winter wheat and other fall-sown grains. There was some complaint of alternate thawing and freezing in the extreme lower Great Plains and parts of the Ohio Valley, but most of the principal Wheat Belt had a good snow cover practically throughout the month. During the latter part much snow disappeared in the central Mississippi Valley and Great Plains and many wheat fields had become bare, but no severe injury from cold was noted, and the ice sheet that persisted over Missouri, west-central Illinois, and parts of the western Lake region apparently did no great amount of harm. Cereal crops made fairly good progress in the Southern States, except in the Southwest where it was too dry, and they were favorably affected by the weather in the Pacific-coast districts.

Ranges, pastures, and livestock.—An unusual amount of feeding of livestock was necessary during the month over the western grazing districts, made necessary by the snow-covered range and, in some sections, by the cold weather. The latter part of the month was more favorable in the Northwest and considerable range was made available, but the long previous period of cold weather

in central Rocky Mountain sections had been hard on stock, which had become thin and weak with some losses reported. The range continued to fail gradually in the more southwestern districts because of the absence of moisture.

Fruit.—Late reports indicated that considerable damage was done to citrus fruit by frost in California during the last week in December, and that limes and lemons were harmed in the lower Rio Grande Valley. In Florida the weather was mostly favorable for citrus; the increased moisture the latter part of the month stimulated growth of trees. Peach buds were damaged somewhat in southern Indiana, and there was some complaint of harm by the cold in the central Rocky Mountain area. Otherwise the month was generally favorable for fruit.

Miscellaneous crops.—In the Southeastern States winter truck made fairly good progress under the influence of weather which was mostly mild and moist. It was unfavorable for planting, however, during much of the month, because of frequent rains and wet soil, while in Florida it was rather too warm for the hardier varieties of truck. In west Gulf districts conditions were less favorable because of damaging cold early in the month, and, in sections not irrigated, because of continued dryness. At the close of the month potatoes had been mostly planted in Florida and much of the early crop was up, though germination was unsatisfactory locally. Conditions were favorable in the far Southwest, and minor crops did well in Pacific-coast districts.

CLIMATOLOGICAL TABLES

DESCRIPTION OF TABLES AND CHARTS

Table I gives the data ordinarily needed for climatological studies for about 176 Weather Bureau stations making simultaneous observations at 8 a. m. and 8 p. m. daily, 75th meridian time, and for about 37 others making only one observation. The altitudes of the instruments above ground are also given.

Table II gives, for about 35 stations of the Canadian Meteorological Service, the means of pressure and temperature, total precipitation, and depth of snowfall, and the respective departures from normal values except in the case of snowfall. The sea level pressures have been computed according to the method described by Prof. F. H. Bigelow in the REVIEW of January, 1902, pages 13–16.

Chart I.—*Tracks of centers* of ANTICYCLONES; and

Chart II.—*Tracks of centers* of CYCLONES. The Roman numerals show the chronological order of the centers. The figures within the circles show the days of the month; the letters *a* and *p* indicate, respectively, the observations at 8 a. m. and 8 p. m., 75th meridian time. Within each circle is also given (Chart I) the last three figures of the highest barometric reading, or (Chart II) the lowest reading reported at or near the center at that time, and in both cases as reduced to sea level and standard gravity. The inset map in Chart I shows the departure of monthly mean pressure from normal and the inset in Chart II shows the change in mean pressure from the preceding month.

Chart III.—*Temperature departures.* This chart presents the departures of the monthly mean surface temperatures from the monthly normals. The shaded portions of the chart indicate areas of positive departures and unshaded portions indicate areas of negative departures. Generalized lines connect places having approximately equal departures of like sign. This chart of monthly surface temperature departures in the United States was first published in the MONTHLY WEATHER REVIEW for July, 1909.

Chart IV.—*Total precipitation.* The scales of shading with appropriate lines show the distribution of the monthly precipitation. The inset on this chart shows the departure of the monthly totals from the corresponding normals.

Chart V.—*Percentage of clear sky between sunrise and sunset.* The average cloudiness at each Weather Bureau station is determined by numerous personal observations between sunrise and sunset. The difference between the observed cloudiness and 100 is assumed to represent the percentage of clear sky, and the values thus obtained are the basis of this chart. The chart does not relate to the nighttime.

Chart VI.—*Isobars at sea level, average surface temperatures, and prevailing wind directions.* The pressures have been reduced to sea level and standard gravity by the method described by Prof. Frank H. Bigelow on pages 13–16 of the REVIEW for January, 1902. The pressures have also been reduced to the mean of the 24 hours by the application of a suitable correction to the mean of 8 a. m. and 8 p. m. readings at stations taking two observations daily, and to the 8 a. m. or the 8 p. m. observation, respectively, at stations taking but a single observation. The diurnal corrections so applied will be found in the Annual Report of the Chief of the Weather Bureau, 1900–1901, volume 2, Table 27, pages 140–164.

The sea level temperatures are now omitted and average surface temperatures substituted. The isotherms can not be drawn in such detail as might be desired, for data from only the regular Weather Bureau stations are used.

The prevailing wind directions are determined from hourly observations at the great majority of the stations. A few stations determine the prevailing direction from the daily or twice-daily observations only.

Chart VII.—*Total snowfall.* This is based on the reports from regular and cooperative observers and shows the depth in inches of the snowfall during the month. In general, the depth is shown by lines inclosing areas of equal snowfall, but in special cases figures are also given. This chart is published only when the snowfall is sufficiently extensive to justify its preparation. The inset to this chart shows the depth of snow on the ground at the end of the month.

Charts VIII, IX, etc.—*North Atlantic weather maps of particular days.*

CLIMATOLOGICAL TABLES[1]

CONDENSED CLIMATOLOGICAL SUMMARY

In the following table are given for the various sections of the climatological service of the Weather Bureau the monthly average temperature and total rainfall; the stations reporting the highest and lowest temperatures, with dates of occurrence; the stations reporting the greatest and least total precipitation; and other data as indicated by the several headings.

The mean temperature for each section, the highest and lowest temperatures, the average precipitation, and the greatest and least monthly amounts are found by using all trustworthy records available.

The mean departures from normal temperatures and precipitation are based only on records from stations that have 10 or more years of observations. Of course, the number of such records is smaller than the total number of stations.

Condensed climatological summary of temperature and precipitation, by sections, January, 1925

Section	Temperature								Precipitation					
	Section average	Departure from the normal	Monthly extremes						Section average	Departure from the normal	Greatest monthly		Least monthly	
			Station	Highest	Date	Station	Lowest	Date			Station	Amount	Station	Amount
	° F.	° F.		° F.			° F.		In.	In.		In.		In.
Alabama	4.4	+1.8	Citronelle	82	9	Riverton	14	28	9.59	+4.68	Troy	18.01	Riverton	3.51
Alaska (December)	12.8	+0.4	2 stations	52	[2] 3	Eagle	−66	12	2.94	−2.35	Ketchikan	9.59	Candle	0.11
Arizona	40.2	−2.8	Yuma date orchard	84	30	Chin Lee	−27	10	0.22	−1.16	Henry's Camp	4.24	9 stations	0.00
Arkansas	40.8	−0.1	Marked Tree	76	6	Mammoth Spring	−4	28	2.68	−1.55	Springbank	5.77	Clinton	1.00
California	46.6	+1.4	2 stations	83	29	Sierraville	−9	15	1.57	−3.87	Crescent City	19.04	3 stations	0.00
Colorado	19.4	−4.6	Edgewater	68	30	Dillon	−42	10	0.37	−0.57	Steamboat Springs	2.99	2 stations	0.00
Florida	63.7	+4.3	Bartow	90	10	2 stations	26	31	5.11	+2.33	Jupiter	13.08	Ritta	1.91
Georgia	48.0	+1.2	Waycross	83	[2] 9	Clayton	12	31	10.84	+6.90	Fort Gaines	18.94	Brunswick	2.70
Hawaii	69.1	+1.3	Walanae	89	[2] 4	3 stations	47	[2] 11	6.01	−2.04	Intake, Wainiha canal	27.50	4 stations	0.00
Idaho	26.4	+2.6	Lewiston	60	30	Gray's Lake	−18	16	2.91	+0.81	Avery	10.23	Oakley	0.21
Illinois	26.7	+0.2	Sparta	62	25	3 stations	−11	14	0.67	−1.77	New Burnside	1.71	Rushville	0.20
Indiana	27.8	−0.8	2 stations	62	[2] 7	Marengo	−20	28	0.78	−2.41	Columbus	1.95	Greenfield	0.22
Iowa	19.4	+0.9	Wescott	55	24	Milford	−24	27	0.40	−0.67	Burlington	1.23	Grundy Center	0.05
Kansas	25.5	−3.4	2 stations	68	25	Burr Oak	−19	17	0.38	−0.30	Pittsburg	1.42	Beaver	0.00
Kentucky	35.7	+0.2	Greenville	66	7	Williamstown	−9	28	2.60	−1.78	Burnside	4.34	Owensboro	1.11
Louisiana	50.9	−0.3	3 stations	82	[2] 9	2 stations	18	[2] 14	7.56	+3.01	Clinton	15.06	Abbeville	3.68
Maryland-Delaware	31.2	−1.4	Salisbury, Md	63	25	Oakland, Md	−31	28	4.68	+1.40	Millsboro, Del	7.63	Hancock, Md	3.14
Michigan	18.1	−1.2	Hastings	49	8	Fife Lake	−36	27	0.93	−0.98	Mancelona	2.16	Petoskey	0.30
Minnesota	8.9	+0.8	Sandy Lake Dam	47	21	Pine River Dam	−41	27	0.50	−0.22	New Ulm	1.90	Alexandria	T.
Mississippi	47.5	+0.3	Leakesville	80	9	Okolona	11	28	8.58	+3.48	Natchez	15.02	Holly Springs	2.48
Missouri	29.7	−0.7	3 stations	65	[2] 24	Goodland	−15	28	1.00	−1.03	Galena	3.31	Chillicothe	0.03
Montana	23.1	+4.5	2 stations	63	[2] 6	Poplar	−37	14	1.07	+0.06	Heron	7.63	Glendive	T.
Nebraska	20.2	−1.7	Bridgeport	65	31	Gordon	−21	1	0.30	−0.25	Hartington	1.05	6 stations	0.00
Nevada	33.3	+3.0	Pahrump	74	31	Battle Mountain	−10	18	0.50	−0.50	Arthur	3.64	3 stations	0.00
New England	17.3	−3.4	Waterbury, Conn	56	8	Van Buren, Me	−48	19	3.20	−0.15	Portland, Me	6.04	Bethlehem, N. H	1.24
New Jersey	27.4	−2.7	Pleasantville	59	26	Layton	−20	28	4.43	+0.81	Belvidere	8.73	Clayton	2.54
New Mexico	29.5	−4.2	2 stations	78	[2] 24	Dulce	−36	12	0.26	−0.34	Doretta	1.00	9 stations	0.00
New York	19.1	−3.6	do	53	[2] 16	Canton	−41	28	3.49	+0.60	High Market	6.16	Lockport	1.63
North Carolina	40.8	−0.6	do	74	26	3 stations	9	[2] 28	6.16	+2.33	Salisbury	9.65	Hot Springs	1.85
North Dakota	8.6	+3.7	Berthold agency	52	23	Napoleon	−35	26	0.22	−0.32	Fullerton	1.17	5 stations	0.00
Ohio	27.2	−1.3	Green	67	7	2 stations	−23	28	1.69	−1.41	Ironton	3.93	North Bass Island	0.49
Oklahoma	35.4	−3.3	Woodward	73	25	Kenton	−7	27	0.94	−0.39	Hugo	3.05	Supply	0.08
Oregon	37.8	+4.5	Cazadero	66	21	Harney branch station	−10	15	5.36	+0.61	Mapleton	21.42	Blitzen	0.15
Pennsylvania	25.2	−2.7	3 stations	55	[2] 7	West Bingham	−29	28	3.49	+0.35	Quakertown	6.68	Westford	1.07
Porto Rico	73.0	−0.2	Arecibo	91	4	Jayuya	49	24	2.05	−1.66	Comerio Falls	6.22	4 stations	0.00
South Carolina	44.9	−0.6	Garnett	76	[2] 17	Cæsar's Head	18	14	8.54	+4.95	Aiken	12.50	Georgetown	4.40
South Dakota	14.5	−1.3	Spearfish	68	30	3 stations	−31	[2] 1	0.61	+0.04	Hardy ranger station	3.87	Dowling	0.09
Tennessee	40.1	+1.0	2 stations	67	7	Cedar Hill	1	28	3.51	−1.42	Copperhill	8.67	Perryville	1.17
Texas	45.6	−2.9	Ricardo	89	25	Dalhart	−3	27	1.39	−0.44	Bronson	6.03	10 stations	0.00
Utah	21.7	−3.6	St. George	62	29	Green River	−24	10	0.50	−0.82	Silver Lake	3.07	6 stations	0.00
Virginia	35.2	−1.2	Roanoke	69	24	Woodstock	−14	28	4.73	+1.24	Urbanna	9.67	Burkes Garden	1.67
Washington	34.1	+3.6	2 stations	62	[2] 19	3 stations	−11	[2] 15	5.83	+0.72	Forks	27.65	Rock Island	0.49
West Virginia	31.1	−1.2	do	63	[2] 21	Moorefield	−27	28	3.81	−0.27	Pickens	7.07	Camden-on-Gauley	1.32
Wisconsin	15.3	+1.3	New London	48	21	4 stations	−39	27	0.43	−0.85	Stanley	1.00	Mather	0.05
Wyoming	20.2	+0.6	Wheatland	64	30	Moran	−30	16	0.53	−0.24	Moran	2.92	3 stations	0.00

[1] For description of tables and charts, see above.
[2] Other dates also.

TABLE 1.—*Climatological data for Weather Bureau stations, January, 1925*

Districts and stations	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dewpoint	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01 or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
	Ft.	*Ft.*	*Ft.*	*In.*	*In.*	*In.*	°*F.*	°*F.*	°*F.*		°*F*	°*F.*		°*F*	°*F.*	°*F.*	°*F.*	%	*In.*	*In.*		*Miles*								*0–10*	*In.*	*In.*
New England							**21.8**	**−2.7**										**74**	**3.36**	**−0.2**										**6.0**		
Eastport	76	67	85	30.03	30.12	+.12	17.0	−3.4	42	13	26	−14	19	8	37	14	9	75	3.24	−0.6	15	10,541	w.	66	ne.	30	10	8	13	5.9	15.8	9.5
Greenville, Me	1,070	6	.....	28.90	30.15	.....	7.0	.....	34	4	18	−25	19	−4	44	.....	.....	.....	2.95	.....	11	.....	se.	.....	.....	.....	13	7	11	.....	29.5	.....
Portland, Me	103	82	117	30.05	30.18	+.13	17.6	−4.8	41	8	26	−7	24	9	28	14	9	71	6.04	+2.2	9	7,335	n.	39	n.	30	14	5	12	5.2	31.9	27.1
Concord	288	70	79	29.84	30.17	+.12	16.8	−4.8	41	22	27	−21	29	6	42	.....	.....	.....	1.79	−1.6	8	4,073	n.	29	ne.	30	12	7	12	5.5	22.9	21.7
Burlington	404	11	48	29.75	30.23	+.18	12.0	−6.8	37	22	22	−26	28	2	38	.....	.....	.....	2.12	+0.3	10	8,969	s.	56	s.	31	6	7	18	6.9	31.0	25.0
Northfield	876	12	60	29.18	30.19	+.14	10.3	−4.9	40	31	22	−32	28	−2	42	9	6	84	2.01	−0.5	14	5,403	s.	32	sw.	31	8	5	18	6.8	33.4	22.2
Boston	125	115	188	30.01	30.16	+.11	27.2	−0.5	48	26	35	0	23	20	35	23	16	65	3.97	+0.2	11	8,850	w.	38	w.	22	8	11	12	5.9	20.7	5.0
Nantucket	12	14	90	30.12	30.13	+.09	31.3	0.0	46	13	37	5	24	26	29	29	25	81	3.64	+0.2	13	15,204	w.	66	sw.	30	10	3	18	6.5	11.7	T.
Block Island	26	11	46	30.11	30.14	+.07	30.3	−0.7	47	16	36	4	24	24	29	27	22	72	3.26	−0.6	10	17,842	w.	66	sw.	30	11	5	15	5.8	6.9	T.
Providence	160	215	251	29.98	30.17	+.11	26.4	−0.8	47	26	34	−1	24	19	35	23	17	73	3.21	−1.2	10	10,691	w.	60	w.	22	9	9	13	5.8	16.2	1.6
Hartford	159	122	140	29.99	30.18	+.11	24.4	−1.1	50	26	33	−5	28	16	36	.....	.....	.....	3.95	+0.1	10	.....	sw.	.....	.....	.....	11	6	14	5.6	17.3	8.5
New Haven	106	74	153	30.06	30.18	+.10	26.0	−2.2	45	8	34	−3	28	18	35	23	17	72	3.70	−0.2	10	8,147	ne.	33	ne.	29	10	6	15	6.0	22.3	3.0
Middle Atlantic States							**31.1**	**−0.9**										**75**	**4.23**	**+1.0**										**6.3**		
Albany	97	102	115	30.10	30.21	+.14	18.5	−4.6	41	26	27	−10	28	10	34	17	14	80	2.53	−0.1	13	5,679	s.	30	n.	27	7	8	16	6.9	26.6	12.5
Binghamton	871	10	84	29.20	30.17	+.11	21.4	−2.7	44	26	30	−22	28	12	32	.....	.....	.....	2.85	+0.9	9	4,600	ne.	28	nw.	22	5	6	20	7.5	36.5	18.0
New York	314	414	454	29.83	30.19	+.09	29.1	−1.8	46	26	36	−1	28	22	39	26	20	69	5.30	+1.5	11	14,030	nw.	68	nw.	23	7	11	13	6.5	25.1	7.4
Harrisburg	374	94	104	29.80	30.22	+.12	27.6	−1.4	47	22	35	−1	28	20	34	24	19	71	3.34	+0.5	9	4,979	ne.	34	nw.	23	6	6	19	7.0	27.2	13.5
Philadelphia	114	123	190	30.07	30.20	+.09	31.8	−0.8	50	22	38	3	28	25	36	28	23	71	4.68	+1.3	10	8,113	ne.	35	ne.	2	8	7	16	6.3	11.6	1.8
Reading	325	81	98	29.84	30.21	.....	27.6	.....	46	25	35	−4	28	20	35	24	20	75	3.83	+0.3	8	3,978	nw.	29	ne.	20	7	10	14	6.3	36.8	9.2
Scranton	805	111	119	29.29	30.20	+.11	24.1	−2.5	46	26	32	−11	28	16	28	22	19	83	2.95	+0.2	11	5,804	nw.	34	sw.	22	8	7	16	7.0	27.0	9.4
Atlantic City	52	37	172	30.12	30.18	+.07	34.4	+1.9	54	22	41	7	28	28	33	31	27	78	4.10	+0.7	14	15,860	w.	78	ne.	2	11	4	16	6.0	4.3	0.0
Cape May	17	13	49	30.19	30.21	+.09	34.7	+0.6	55	26	41	8	28	29	34	32	30	84	5.34	+2.0	13	7,796	ne.	38	ne.	2	13	2	16	6.0	5.2	T.
Sandy Hook	22	10	55	30.16	30.18	.....	29.1	.....	43	8	34	4	28	24	31	26	22	75	3.74	.....	11	14,650	ne.	62	n.	20	8	8	15	6.3	16.3	2.6
Trenton	190	159	183	29.98	30.19	.....	29.4	.....	47	25	37	−1	28	22	35	26	20	71	4.31	+1.1	9	8,764	ne.	46	e.	20	6	7	18	7.0	18.5	2.8
Baltimore	123	100	113	30.06	30.20	+.08	33.0	−0.8	55	22	40	4	28	26	35	29	24	72	5.35	+2.1	12	4,481	ne.	20	n.	27	11	3	17	6.2	18.7	2.8
Washington	112	62	85	30.08	30.21	+.08	32.9	−0.5	58	25	41	3	28	25	40	28	23	69	4.44	+1.1	13	5,050	nw.	32	nw.	13	13	2	16	6.1	18.0	2.0
Cape Henry	18	8	54	30.15	30.17	.....	40.8	.....	65	26	48	19	28	33	38	36	33	82	5.41	+2.1	15	11,189	ne.	58	n.	23	12	3	16	5.9	0.6	0.0
Lynchburg	681	153	188	29.44	30.21	+.08	37.4	−0.1	64	26	46	7	28	28	36	32	26	71	3.40	−0.3	11	5,665	w.	37	nw.	22	13	4	14	5.5	2.2	0.5
Norfolk	91	170	205	30.09	30.19	+.06	41.0	+0.4	63	25	49	18	28	33	40	36	32	76	6.22	+2.8	17	10,727	ne.	53	w.	2	11	4	16	5.9	0.7	0.0
Richmond	144	11	52	30.05	30.21	+.08	36.6	−1.3	65	25	45	8	28	28	42	32	28	77	5.42	+2.4	14	6,408	sw.	28	sw.	20	13	4	14	5.6	1.6	T.
Wytheville	2,304	49	55	27.73	30.20	+.06	33.5	+0.5	57	26	41	10	28	26	34	30	26	79	2.36	−1.9	12	4,613	w.	27	nw.	22	11	1	19	6.2	6.2	0.0
South Atlantic States							**46.1**	**+0.6**										**81**	**6.46**	**+2.8**										**6.3**		
Asheville	2,255	70	84	27.77	30.21	+.06	37.6	+2.2	59	27	46	18	31	29	37	33	29	77	2.74	−0.1	9	6,488	se.	34	se.	11	11	4	16	5.8	T.	0.0
Charlotte	779	55	62	29.34	30.20	+.05	40.5	−0.7	64	27	48	21	28	33	34	36	32	76	6.91	+2.6	14	4,112	ne.	22	ne.	27	12	2	17	6.4	1.0	0.0
Hatteras	11	11	50	30.15	30.16	+.02	46.6	−0.5	66	26	54	29	24	40	33	43	41	87	6.45	+1.5	14	11,137	n.	50	n.	27	10	6	15	6.2	0.0	0.0
Manteo	12	5	42	.....	.....	.....	43.0	.....	64	8	.....	23	15	.....	32	.....	.....	.....	6.72	.....	12	.....	n.	.....	.....	.....	9	7	15	.....	0.0	0.0
Raleigh	376	103	110	29.79	30.21	+.08	40.7	−0.4	66	27	49	17	28	32	43	36	31	77	5.69	+2.1	13	6,077	ne.	30	ne.	27	9	6	16	6.2	0.4	T.
Wilmington	78	81	91	30.12	30.20	+.06	46.3	−0.2	72	26	54	24	28	38	32	43	40	84	5.36	+1.9	13	4,800	n.	25	n.	27	7	9	15	6.4	0.0	0.0
Charleston	48	11	92	30.13	30.18	+.03	50.6	+0.7	68	27	58	32	28	43	29	46	43	84	4.85	+1.4	10	7,327	ne.	36	ne.	19	7	7	17	6.7	0.0	0.0
Columbia, S. C	351	41	57	29.81	30.21	+.06	44.9	−1.1	69	26	53	26	28	36	29	40	37	82	10.03	+6.7	10	4,385	ne.	26	ne.	28	8	8	15	6.5	0.0	0.0
Due West	711	10	55	29.42	30.22	.....	41.9	.....	64	26	51	23	14	33	28	.....	.....	.....	6.96	.....	12	6,496	ne.	33	ne.	18	10	4	17	6.0	0.0	0.0
Greenville, S. C	1,039	113	122	29.06	30.18	.....	41.6	+1.3	62	26	50	26	29	34	26	37	33	77	7.12	.....	13	4,324	e.	28	n.	23	12	3	16	5.9	0.0	0.0
Augusta	180	62	77	29.99	30.19	+.03	46.4	−0.6	69	27	55	29	14	38	32	42	39	85	12.60	+8.4	10	3,506	nw.	21	ne.	28	8	8	15	6.4	0.0	0.0
Savannah	65	150	194	30.10	30.17	+.02	53.6	+2.2	78	17	62	34	28	45	29	47	45	82	5.49	+2.4	9	7,907	ne.	39	w.	11	7	8	16	6.5	0.0	0.0
Jacksonville	43	209	245	30.10	30.15	.00	58.6	+3.2	79	18	66	36	14	52	21	53	51	84	4.52	+1.4	10	8,889	ne.	40	w.	11	7	8	16	6.6	0.0	0.0
Florida Peninsula							**71.2**	**+5.4**										**84**	**3.89**	**+1.4**										**5.4**		
Key West	22	10	64	30.06	30.08	−.02	75.0	+5.5	83	1	79	63	26	71	16	70	68	85	2.22	+0.2	9	6,877	se.	30	n.	24	15	9	7	4.4	0.0	0.0
Miami	25	71	79	30.09	30.12	.....	73.0	+5.7	81	12	78	55	31	68	18	68	66	84	4.78	+2.0	16	5,429	se.	28	e.	16	12	10	9	5.3	0.0	0.0
Sand Key	23	39	72	30.06	30.10	−.02	74.3	.....	82	1	76	66	24	72	8	70	68	81	2.53	.....	6	10,188	se.	40	e.	15	14	10	7	4.7	0.0	0.0
Tampa	35	79	87	30.08	30.12	.00	65.5	+5.1	81	10	72	45	31	58	28	60	58	86	4.66	+1.9	8	4,686	ne.	26	ne.	24	4	11	16	7.1	0.0	0.0
East Gulf States							**49.8**	**+1.6**										**81**	**8.57**	**+3.6**										**6.2**		
Atlanta	1,174	190	216	28.91	30.18	+.03	43.1	+0.5	64	26	50	26	28	36	33	40	36	80	11.08	+5.8	14	8,243	e.	38	ne.	18	9	4	18	6.8	0.0	0.0
Macon	370	78	87	29.77	30.18	+.02	47.0	+0.2	72	11	56	26	31	38	32	43	40	84	13.22	+8.0	12	3,946	ne.	24	ne.	18	9	3	19	6.8	0.0	0.0
Thomasville	273	49	58	29.85	30.15	−.01	55.9	+4.9	78	17	64	32	30	48	27	51	48	82	6.26	+2.1	12	3,541	ne.	22	ne.	28	6	4	21	7.2	0.0	0.0
Apalachicola	36	42	49	30.10	30.14	.....	57.0	.....	73	17	62	38	14	52	18	53	51	86	4.62	.....	7	5,912	n.	31	e.	23	8	5	18	6.3	0.0	0.0
Pensacola	56	149	185	30.08	30.14	.00	54.6	+2.1	71	8	61	37	6	48	25	51	48	83	6.10	+2.1	14	9,127	n.	48	s.	10	9	6	16	6.3	0.0	0.0
Anniston	741	9	57	29.38	30.19	+.03	44.8	+2.6	67	26	54	22	14	36	36	.....	.....	.....	7.80	+2.5	15	4,120	se.	30	se.	18	11	2	18	6.4	0.0	0.0
Birmingham	700	11	48	29.41	30.19	+.03	45.6	+1.5	65	7	54	23	28	39	32	42	37	75	7.58	+2.3	14	4,824	n.	28	se.	15	11	4	16	6.1	0.0	0.0
Mobile	57	125	161	30.08	30.14	−.01	53.1	+0.9	72	9	61	35	14	45	29	49	46	82	7.59	+2.7	12	6,547	n.	33	n.	27	9	11	11	5.7	0.0	0.0
Montgomery	223	100	112	29.91	30.17	+.01	50.2	+2.0	72	11	58	31	14	42	30	45	41	77	12.01	+6.9	13	4,429	e.	24	w.	11	8	7	16	6.5	0.0	0.0
Meridian	375	85	93	29.75	30.16	.00	48.0	+1.0	69	25	57	26	28	39	36	43	40	80	8.57	+3.0	11	3,714	ne.	25	w.	11	12	3	16	5.9	T.	0.0
Vicksburg	247	65	73	29.89	30.18	+.03	48.2	0.0	71	7	57	21	28	40	31	43	38	76	9.05	+3.4	12	4,778	se.	25	w.	12	12	4	15	5.8	0.0	0.0
New Orleans	53	76	84	30.08	30.14	+.01	55.8	+1.6	81	9	64	36	28	48	26	51	48	82	5.02	+0.4	11	4,931	n.	26	sw.	11	14	6	11	4.6	0.0	0.0
West Gulf States							**47.0**	**−1.1**										**77**	**1.88**	**−1.1**										**5.0**		
Shreveport	249	77	93	29.89	30.17	+.03	46.1	−0.9	68	26	55	22	28	37	31	41	37	75	4.65	+0.2	11	4,378	se.	25	w.	12	17	3	11	4.6	0.0	0.0
Bentonville	1,303	11	44	.....	.....	.....	36.0	+1.9	64	25	46	6	28	26	40	.....	.....	.....	1.51	.....	5	3,574	s.	16	s.	16	15	4	12	.....	4.5	0.0
Fort Smith	457	79	94	29.65	30.15	+.01	39.1	−0.4	68	25	48	18	27	30	35	35	31	76	1.41	−1.1	11	5,834	e.	27	w.	7	10	9	12	5.5	0.9	0.0
Little Rock	357	136	144	29.77	30.16	+.01	41.8	+0.4	64	6	50	14	28	33	34	37	31	71	1.51	−3.3	12	5,617	s.	34	sw.	7	12	4	15	5.4	0.6	T.
Brownsville	57	53	61	30.04	30.10	.....	58.8	−1.0	80	9	68	30	28	49	30	53	50	83	0.42	.....	5	5,639	n.	28	ne.	27	9	12	10	5.3	0.0	0.0
Corpus Christi	20	11	73	30.12	30.14	+.04	53.6	−2.4	74	8	62	30	27	46	30	49	47	86	0.25	−2.0	6	7,607	n.	44	n.	26	13	2	16	5.3	T.	0.0
Dallas	512	109	117	29.62	30.18	.....	43.6	.....	71	6	54	19	27	33	36	.....	.....	.....	1.68	.....	10	5,854	nw.	31	nw.	16	14	7	10	4.8	T.	0.0
Fort Worth	670	106	114	29.41	30.14	+.02	43.4	−2.0	73	6	55	17	27	32	40	38	31	68	1.44	+0.5	5	6,871	nw.	32	w.	1	13	8	10	4.6	0.0	0.0
Galveston	54	106	114	30.09	30.15	+.02	51.7	−2.1	69	7	58	32	27	46	22	49	47	88	4.54	+0.9	8	7,289	n.	32	nw.	27	12	8	11	5.1	0.0	0.0
Groesbeck	461	11	56	29.67	30.16	.....	44.6	.....	70	6	56	21	27	34	39	.....	.....	.....	1.75	.....	8	7,035	s.	35	nw.	26	13	7	11	4.7	0.0	0.0
Houston	138	111	121	30.00	30.15	.....	51.0	−1.7	77	7	61	28	27	41	32	.....	.....	.....	5.41	.....	10	4,930	n.	28	n.	27	12	8	11	5.0	0.0	0.0
Palestine	510	64	72	29.61	30.16	+.04	45.4	−2.8	69	6	55	24	27	36	40	41	36	74	2.23	−1.6	9	5,235	n.	24	nw.	26	13	8	10	5.1	T.	0.0
Port Arthur	34	58	66	30.10	30.14	.....	51.8	.....	73	16	60	32	28	44	28	48	45	85	4.35	.....	9	5,868	e.	36	se.	15	11	8	12	5.4	0.0	0.0
San Antonio	693	119	132	29.40	30.14	+.04	50.5	−1.8	77	7	62	25	28	38	44	43	36	63	0.36	−1.3	4	5,609	n.	30	w.	12	17	4	10	4.3	0.0	0.0
Taylor	583	55	63	29.56	30.18	+.07	47.1	−0.4	75	7	59	21	28	35	38	.....	.....	.....	0.57	−2.2	5	5,572	nw.	30	nw.	26	14	3	14	4.8	T.	0.0

TABLE 1.—*Climatological data for Weather Bureau stations, January, 1925*—Continued

Districts and stations	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. +2 mean min. ÷2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dewpoint	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01 or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
Ohio Valley and Tennessee	*Ft.*	*Ft.*	*Ft.*	*In.*	*In.*	*In.*	°*F.*	°*F.*	°*F.*		°*F*	°*F*		°*F*	°*F.*	°*F.*	°*F.*	%	*In.*	*In.*		*Miles*								0–10	*In.*	*In.*
							34.3	**+0.7**										**75**	**2.47**	**−1.4**										**6.4**		
Chattanooga	762	189	213	29.35	30.19	+.03	43.2	+2.0	61	22	51	22	28	36	31	38	33	74	4.74	−0.8	15	5,480	ne.	30	w.	12	11	2	18	6.1	T.	0.0
Knoxville	996	102	111	29.09	30.18	+.03	41.5	+2.7	60	22	48	19	28	34	30	37	33	77	3.78	−1.2	14	4,785	ne.	31	sw.	20	11	7	13	5.9	T.	0.0
Memphis	399	76	97	29.74	30.18	+.02	41.6	+0.7	63	7	48	12	28	35	32	37	32	73	1.63	−3.6	10	5,613	n.	28	n.	27	12	5	14	5.5	0.4	0.0
Nashville	546	168	191	29.60	30.20	+.04	39.9	+1.3	61	7	48	8	28	32	30	36	31	74	2.70	−2.2	10	6,566	ne.	39	w.	12	10	7	14	5.8	0.7	T.
Lexington	989	193	230	29.10	30.21	+.08	32.8	−0.1	57	7	40	−4	28	26	39				3.41	−0.4	13	10,355	sw.	35	sw.	7	12	1	18	6.1	5.1	0.5
Louisville	525	188	234	29.61	30.21	+.07	34.1	−0.3	59	25	41	−2	28	27	35	30	25	70	2.02	−1.9	11	8,004	s.	36	nw.	26	8	9	14	6.3	6.0	1.0
Evansville	431	139	175	29.72	30.20	+.06	34.6	+1.1	59	25	42	1	28	27	34	31	25	71	1.43	−2.3	10	8,123	ne.	35	ne.	26	7	14	10	6.3	4.6	T.
Indianapolis	822	194	230	29.27	30.19	+.07	29.0	+0.6	51	31	37	2	28	21	37	26	22	78	0.49	−2.3	7	8,556	s.	32	sw.	31	9	9	13	5.9	3.7	0.0
Royal Center	736	11	55	29.36	30.20	------	21.6	------	45	31	31	−4	14	12	36	------	------	------	0.57	------	5	7,216	sw.	34	nw.	22	5	4	22	7.8	6.4	1.0
Terre Haute	575	96	129	29.54	30.19	------	29.0	------	51	24	37	4	28	21	31	26	21	74	0.35	------	6	6,851	s.	34	n.	26	8	13	10	5.7	3.1	0.0
Cincinnati	628	11	51	29.50	30.20	+.08	30.8	+0.5	55	7	38	−6	28	23	39	------	------	27	85	1.91	−1.4	10	6,188	sw.	27	ne.	26	9	7	15	6.3	11.1	1.0
Columbus	824	179	222	29.28	30.19	+.08	28.8	+0.2	50	7	37	−3	28	21	37	26	22	76	1.48	−1.5	10	7,591	w.	41	nw.	22	5	10	16	7.1	11.3	0.9
Dayton	899	137	173	29.19	30.19	------	28.9	−0.6	48	7	37	−2	28	21	40	26	22	76	0.95	−2.1	11	7,225	sw.	33	nw.	22	9	8	14	6.5	8.9	0.5
Elkins	1,947	59	67	28.06	30.21	+.09	32.3	+1.9	56	7	42	−15	28	23	48	28	24	80	4.12	+0.8	17	4,548	w.	29	nw.	22	6	8	17	7.1	9.7	3.9
Parkersburg	638	77	84	29.53	30.21	+.09	33.0	+0.5	58	7	41	−5	28	25	33	29	24	73	2.71	−0.5	14	3,894	sw.	32	w.	22	7	6	18	7.1	9.7	3.0
Pittsburgh	842	353	410	29.25	30.19	+.08	29.8	−0.9	53	7	37	−3	28	23	33	27	23	75	3.16	+0.3	14	8,984	w.	53	nw.	22	2	11	18	7.6	26.2	10.0
Lower Lake Region							**21.6**	**−2.9**										**80**	**2.19**	**−0.5**										**6.9**		
Buffalo	767	247	280	29.30	30.17	+.10	21.7	−2.9	42	26	29	−6	28	15	37	20	17	81	2.27	−1.0	15	13,930	w.	64	w.	22	4	6	21	7.7	19.2	12.5
Canton	448	10	61	29.67	30.18	------	8.2	−8.1	41	31	19	−41	28	−3	50	------	------	------	2.56	−0.6	13	8,043	e.	51	sw.	31	11	6	14	5.9	29.5	24.0
Oswego	335	76	91	------	30.18	+.11	19.4	−4.5	42	31	28	−16	28	11	39	------	------	86	2.25	−0.9	15	------	sw.	40	nw.	22	2	5	24	----	39.3	23.5
Rochester	523	86	102	29.58	30.18	+.11	22.6	−2.0	44	31	30	0	27	15	37	20	16	76	3.37	+0.2	20	7,230	w.	41	w.	22	2	8	21	7.9	34.0	17.0
Syracuse	597	97	113	29.53	30.21	+.14	20.6	−3.0	44	31	28	−16	28	12	37	------	------	------	5.87	+3.7	16	8,595	w.	45	s.	31	4	5	22	7.6	56.5	30.0
Erie	714	130	166	29.87	30.17	+.09	24.9	−1.9	45	26	32	−4	28	18	36	23	20	80	1.19	−1.8	11	11,864	sw.	50	se.	2	4	10	17	7.4	11.5	2.6
Cleveland	762	190	201	29.33	30.18	+.09	25.6	−0.9	45	26	33	0	28	18	34	23	19	76	1.49	−1.0	11	9,400	s.	52	nw.	22	6	8	17	7.2	12.6	0.3
Sandusky	629	62	70	29.48	30.20	+.11	25.2	−1.1	45	31	32	2	28	18	37	------	------	------	0.95	−1.2	11	6,419	sw.	35	nw.	22	5	7	19	7.2	9.1	0.0
Toledo	628	208	243	29.48	30.20	+.11	23.6	−2.2	44	31	31	−3	28	16	37	21	17	78	0.84	−1.1	8	11,187	sw.	48	w.	22	9	7	15	6.0	8.7	T.
Fort Wayne	856	113	124	29.23	30.19	------	23.6	−3.3	46	31	32	−4	28	16	36	22	19	83	0.77	------	8	6,845	sw.	37	w.	22	6	10	15	6.3	7.6	T.
Detroit	730	218	258	29.36	30.19	+.11	22.5	−1.9	42	31	30	−5	28	15	36	20	17	82	1.08	−0.9	12	8,746	sw.	43	sw.	31	9	9	13	6.0	10.5	1.3
Upper Lake Region							**18.2**	**−0.6**										**82**	**0.82**	**−1.2**										**7.0**		
Alpena	609	13	92	29.46	30.16	+.12	17.8	−1.3	39	31	25	−6	19	10	30	16	14	83	0.95	−1.2	13	8,835	nw.	48	nw.	31	0	14	17	7.7	12.7	6.0
Escanaba	612	54	60	29.45	30.15	+.10	16.4	+1.0	39	21	24	−3	14	9	28	15	13	86	0.45	−1.1	12	6,574	nw.	35	nw.	22	7	9	15	6.7	7.3	4.5
Grand Haven	632	54	89	29.45	30.17	+.10	21.8	−2.5	39	31	29	−10	27	14	33	21	18	84	0.84	−2.0	10	8,718	w.	40	w.	22	4	8	19	7.4	7.5	2.6
Grand Rapids	707	70	87	29.37	30.18	+.12	22.2	−2.3	41	31	29	−9	27	15	33	20	16	77	0.59	−2.2	7	4,789	e.	27	nw.	22	4	8	19	7.4	7.7	4.0
Houghton	668	62	99	29.34	30.11	+.06	15.6	+0.9	42	21	23	−12	27	9	35	------	------	------	1.47	−0.6	16	7,437	e.	45	sw.	21	2	6	23	8.6	15.2	18.5
Lansing	878	11	62	29.18	30.16	------	18.6	−3.8	42	31	28	−12	28	9	37	17	14	85	0.90	−1.2	9	4,609	sw.	33	nw.	22	11	8	12	5.9	10.2	3.8
Ludington	637	60	66	29.43	30.15	------	21.0	------	38	31	28	−11	27	14	23	20	17	82	0.85	------	10	8,281	w.	44	sw.	21	4	10	17	7.3	14.2	4.6
Marquette	734	77	111	29.30	30.14	+.10	17.9	+1.6	42	21	24	0	14	12	23	16	13	83	0.98	−1.1	14	8,454	w.	51	s.	28	1	5	25	8.7	24.7	16.0
Port Huron	638	70	120	29.44	30.16	+.10	19.7	−2.6	40	31	27	−10	28	12	33	19	16	84	0.69	−1.2	8	8,335	sw.	36	ne.	26	6	11	14	6.6	9.2	4.5
Saginaw	641	69	77	29.45	30.17	------	18.8	−2.9	41	31	27	−12	28	11	35	17	14	83	0.88	−1.4	7	6,408	sw.	32	w.	31	3	12	16	7.1	8.8	7.3
Sault Saint Marie	614	11	52	29.42	30.16	+.13	11.4	−1.9	35	21	20	−25	27	2	35	10	6	80	1.61	−0.6	19	6,079	se.	50	nw.	31	4	9	18	7.5	16.2	18.5
Chicago	823	140	310	29.25	30.18	+.08	25.9	+0.8	44	31	32	5	28	20	33	24	19	74	0.68	−1.3	5	7,908	w.	33	s.	6	9	10	12	6.2	6.8	T.
Green Bay	617	109	141	29.44	30.14	+.08	16.9	+1.2	40	31	25	−8	27	9	30	15	13	85	0.27	−1.4	6	7,830	s.	39	sw.	21	9	7	15	6.1	3.0	0.1
Milwaukee	681	125	139	29.39	30.16	+.08	22.5	+1.9	43	31	30	0	27	15	32	21	17	79	0.84	−1.2	5	8,107	w.	33	ne.	26	6	14	11	6.2	9.2	T.
Duluth	1,133	5	47	28.84	30.14	+.05	9.6	+1.7	43	21	18	−22	26	1	29	8	6	87	0.27	−0.7	5	9,461	nw.	46	nw.	20	15	4	12	5.1	2.9	4.6
North Dakota							**9.6**	**+5.0**										**82**	**0.26**	**−0.4**										**6.2**		
Moorhead	940	50	58	29.08	30.16	+.02	7.8	+4.0	40	21	17	−21	26	−1	35	6	2	81	0.28	−0.4	6	6,576	n.	32	s.	23	11	10	10	5.4	2.3	T.
Bismarck	1,674	8	57	28.26	30.15	+.02	12.0	+4.2	47	23	23	−29	26	1	46	9	6	82	0.32	−0.2	5	6,265	nw.	44	nw.	31	6	7	18	7.1	7.3	1.1
Devils Lake	1,478	11	44	28.44	30.10	−.02	6.4	+6.1	40	23	16	−21	14	−4	36	5	3	87	0.12	−0.5	4	7,700	nw.	35	w.	6	7	11	13	6.0	2.2	1.5
Ellendale	1,457	10	56	28.50	30.15	------	8.8	------	42	21	20	−24	26	−2	49	------	------	------	0.42	------	10	10,166	nw.	54	nw.	31	6	7	18	7.1	7.4	3.6
Grand Forks	835	12	89	------	------	------	5.3	------	39	21	15	−23	15	−4	33	3	------	------	0.20	------	6	------	nw.	47	s.	27	12	7	12	----	2.0	3.6
Williston	1,878	41	48	27.98	30.06	−0.5	12.1	+5.7	50	23	22	−27	14	2	41	10	7	80	0.31	−0.3	6	5,640	se.	42	w.	6	9	12	10	5.4	2.9	1.7
Upper Mississippi Valley							**22.8**	**+1.4**										**80**	**0.44**	**−1.3**										**5.4**		
Minneapolis	918	102	208	29.11	30.14	------	14.3	+1.6	42	21	23	−17	26	6	33	------	------	------	0.46	−0.2	5	8,083	s.	36	n.	25	7	13	11	5.7	5.4	5.2
St. Paul	837	236	261	29.21	30.16	+.05	13.6	+1.0	40	21	22	−23	27	5	36	------	------	------	0.58	−0.3	6	8,557	nw.	45	nw.	31	7	18	6	5.3	8.1	5.0
La Crosse	714	11	48	29.36	30.17	+.06	17.2	+1.1	42	31	27	−22	27	8	36	------	------	------	0.47	−0.6	5	3,854	se.	22	w.	22	11	9	11	5.5	4.9	2.6
Madison	974	70	78	29.08	30.19	+.09	18.4	+1.7	43	31	27	−8	27	10	33	17	14	82	0.41	−1.2	7	6,255	nw.	40	ne.	26	5	15	11	6.3	4.6	0.5
Wausau	1,247	4	----	28.76	30.16	------	14.0	------	36	31	22	−22	27	6	34	------	------	------	0.85	------	8	------	nw.	25	n.	25	11	13	7	4.7	1.6	2.1
Charles City	1,015	10	49	29.05	30.18	+.04	16.8	+3.1	39	24	26	−16	14	8	35	15	12	87	0.10	−0.9	3	4,948	se.	25	n.	25	12	8	4	4.7	1.4	0.1
Davenport	606	71	79	29.50	30.20	+.08	22.4	+0.6	45	31	31	−4	27	14	34	21	18	83	0.40	−1.2	3	4,978	w.	23	s.	6	8	10	13	5.7	3.4	0.0
Des Moines	861	84	97	29.23	30.18	+.04	22.3	+2.2	45	24	32	−7	27	12	36	20	16	81	0.23	−1.0	2	5,161	n.	28	sw.	31	11	12	8	4.7	2.5	T.
Dubuque	700	81	96	29.38	30.17	+.05	21.6	+2.5	46	31	30	−6	27	13	33	19	15	77	0.11	−1.4	3	4,610	nw.	29	nw.	31	8	13	10	5.8	1.2	T.
Keokuk	614	64	78	29.49	30.20	+.06	25.4	+0.5	52	25	35	−2	27	16	29	22	17	71	0.35	−1.3	4	5,006	e.	25	n.	26	12	11	8	5.1	5.6	T.
Cairo	358	87	93	29.79	30.18	+.02	36.8	+1.9	60	7	44	6	28	29	32	32	27	72	1.21	−2.6	9	7,014	n.	38	n.	26	9	8	14	6.0	3.4	T.
Peoria	609	11	45	29.51	30.20	+.08	23.5	+0.4	46	31	32	2	27	15	30	21	19	90	0.48	−1.7	3	4,796	s.	24	n.	26	16	9	6	4.1	5.1	0.1
Springfield, Ill	636	10	91	29.47	30.17	+.04	27.2	+0.7	50	31	35	3	13	19	35	24	22	83	0.42	−1.8	4	5,986	w.	30	n.	26	15	6	10	4.6	2.9	T.
Hannibal	534	74	109	29.59	30.19	+.06	27.4	+0.3	53	25	36	1	13	19	30	------	------	------	0.39	−1.8	4	5,867	sw.	35	ne.	26	14	9	8	4.7	2.2	0.6
St. Louis	568	265	303	29.55	30.18	+.04	33.0	+2.2	57	25	41	8	27	25	39	29	24	71	0.53	−1.7	5	8,383	s.	34	s.	31	12	8	11	5.3	4.9	0.0
Missouri Valley							**22.7**	**0.0**										**79**	**0.65**	**−0.3**										**4.8**		
Columbia, Mo	784	11	84	29.31	30.18	+.05	29.0	−0.2	53	24	37	1	13	20	31	------	------	------	0.82	−1.4	6	5,437	s.	28	n.	26	17	5	11	4.7	6.3	T.
Kansas City	963	161	181	29.11	30.18	+.03	29.3	+0.1	55	24	38	−1	27	21	29	25	21	74	0.26	−0.9	5	7,271	n.	35	n.	26	17	8	6	3.6	2.4	T.
St. Joseph	967	11	49	29.09	30.17	------	26.6	------	52	24	36	−4	27	17	31	23	20	81	0.27	------	5	5,408	sw.	29	nw.	26	18	6	7	3.6	2.5	T.
Springfield, Mo	1,324	98	104	28.71	30.16	+.02	33.2	−0.3	59	25	42	4	27	25	40	29	25	78	1.58	−1.1	5	7,122	se.	35	se.	15	5	5	11	4.8	7.8	0.0
Iola	984	11	50	29.08	30.18	+.04	28.4	+0.8	58	25	39	−3	27	18	33	------	------	------	0.59	−0.4	5	4,589	n.	26	n.	26	13	10	8	5.0	9.0	0.0
Topeka	987	92	107	------	------	------	26.5	−1.2	51	24	36	0	27	17	32	------	------	------	0.28	−0.6	4	6,475	n.	37	n.	26	15	10	6	3.8	5.6	0.0
Drexel	1,299	10	54	28.71	30.17	------	19.3	------	43	24	29	−8	27	10	29	------	------	------	0.69	------	4	7,485	n.	29	n.	25	14	9	8	5.0	9.1	6.0
Lincoln	1,189	11	84	28.85	30.18	+.03	22.7	−0.1	49	24	32	−5	27	14	37	20	17	82	0.64	0.0	4	6,460	n.	34	n.	25	10	7	14	5.5	7.2	2.5
Omaha	1,105	115	122	28.95	30.19	+.04	22.5	+0.6	47	24	31	−7	27	14	40	20	16	78	0.80	+0.2	6	5,748	n.	40	n.	26	12	13	6	4.6	9.0	3.9
Valentine	2,598	47	54	27.30	30.14	+.02	19.0	+0.1	52	30	32	−15	16	6	39	16	13	80	0.44	−0.1	5	6,391	w.	40	sw.	27	13	11	7	4.4	7.7	T.
Sioux City	1,135	94	164	28.91	30.19	+.04	17.5	−0.3	44	21	26	−11	27	9	41	15	11	78	0.66	+0.1	6	7,977	s.	47	n.	20	12	9	10	5.1	7.5	4.8
Huron	1,306	59	74	28.71	30.19	+.03	12.4	+1.1	45	21	22	−19	26	3	35	10	8	83	0.47	0.0	4	6,793	s.	40	nw.	31	7	15	9	5.7	5.7	1.6
Pierre	1,572	70	75	28.40	30.15	+.02	15.6	−0.4	43	23	25	−14	16	6	45	14	10	79	0.53	+0.1	4	5,438	e.	42	nw.	31	10	7	14	5.7	7.9	2.0
Yankton	1,233	49	57	28.80	30.19	+.03	16.7	−0.6	45	21	27	−12	26	7	43	------	------	------	0.71	+0.2	5	5,304	w.	31	nw.	31	7	9	15	6.2	8.0	4.0

TABLE 1.—*Climatological data for Weather Bureau stations, January, 1925*—Continued

Districts and stations	Elevation of instruments: Barometer above sea level	Elevation of instruments: Thermometer above ground	Elevation of instruments: Anemometer above ground	Pressure: Station, reduced to mean of 24 hours	Pressure: Sea level, reduced to mean of 24 hours	Pressure: Departure from normal	Temperature of the air: Mean max. + mean min. ÷2	Temperature of the air: Departure from normal	Temperature of the air: Maximum	Temperature of the air: Date	Temperature of the air: Mean maximum	Temperature of the air: Minimum	Temperature of the air: Date	Temperature of the air: Mean minimum	Temperature of the air: Greatest daily range	Mean wet thermometer	Mean temperature of the dewpoint	Mean relative humidity	Precipitation: Total	Precipitation: Departure from normal	Precipitation: Days with 0.01, or more	Wind: Total movement	Wind: Prevailing direction	Wind: Maximum velocity: Miles per hour	Wind: Maximum velocity: Direction	Wind: Maximum velocity: Date	Clear days	Partly cloudy days	Cloudy days	Average cloudiness, tenths	Total snowfall	Snow, sleet, and ice on ground at end of month
Northern Slope	*Ft.*	*Ft.*	*Ft.*	*In.*	*In.*	*In.*	°F.	°F.	°F.		°F	°F.		°F	°F.	°F.	°F.	%	*In.*	*In.*		*Miles*							*0–10*	*In.*	*In.*
							22.6	**+3.3**			**58**	**30**	**38**	**−16**	**15**	**15**	**38**	**70**	**0.43**	**−0.4**									**6.0**		
Billings	3,140	5					26.8				58	30	38	−16	15	15	38		0.35		4		sw.				13	8	10		6.0	0.0
Havre	2,505	11	44	27.27	30.02	−.08	17.0	+4.1	52	22	28	−21	15	6	41	16	14	84	0.39	−0.3	10	6,581	sw.	36	sw.	5	6	13	12	6.4	3.8	3.0
Helena	4,110	87	112	25.71	30.01	−.14	29.4	+9.2	55	20	37	0	15	21	33	25	19	63	0.41	−0.5	9	6,916	sw.	48	sw.	2	2	16	13	7.4	4.9	0.0
Kalispell	2,973	48	56	26.85	29.98	−.14	27.3	+6.9	48	30	34	−2	15	21	29	25	22	80	0.88	−0.7	17	3,845	nw.	34	sw.	5	1	6	24	8.3	6.6	5.0
Miles City	2,371	48	55	27.46	30.12	.00	18.0	+3.5	52	23	28	−18	16	8	42	17	10	77	0.43	−0.2	6	4,411	s.	36	w.	5	7	10	14	6.2	4.9	2.0
Rapid City	3,259	50	58	26.57	30.13	+.03	23.8	+1.8	59	30	37	−15	1	11	37	20	14	66	0.30	−0.1	5	4,826	w.	32	nw.	19	7	15	9	5.5	3.4	0.4
Cheyenne	6,088	84	101	23.94	30.10	+.05	26.6	+1.1	56	30	36	4	26	17	40	21	12	55	0.03	−0.4	2	13,382	w.	56	w.	2	9	13	9	5.6	0.2	T.
Lander	5,372	60	68	24.60	30.15	+.03	20.8	+2.5	48	27	33	−6	16	8	37	17	9	60	0.04	−0.4	1	3,454	sw.	40	w.	2	12	18	1	4.2	0.4	3.0
Sheridan	3,790	10	47	26.04	30.08		24.6		61	30	38	−11	26	12	40	19	12	61	0.25		6	3,421	nw.	37	nw.	3	6	19	6	5.6	3.3	T.
Yellowstone Park	6,241	11	48	23.81	30.15	+.01	20.6	+3.0	42	30	27	−5	26	14	34	18	14	75	1.32	−0.9	22	8,092	s.	37	s.	5	0	13	18	7.5	14.3	17.8
North Platte	2,821	11	51	27.13	30.21	+.09	20.2	−2.7	49	30	32	−11	1	9	34	16	13	83	0.07	−0.4	2	4,596	w.	35	nw.	28	18	7	6	3.8	1.1	T.
Middle Slope							**28.4**	**−2.1**										**74**	**0.37**	**−0.3**									**4.0**		
Denver	5,292	106	113	24.70	30.11	+.06	31.4	+1.6	65	30	43	5	15	20	41	24	15	55	0.13	−0.3	3	5,990	s.	35	w.	3	18	10	3	3.4	3.0	0.0
Pueblo	4,685	80	86	25.29	30.14	+.09	26.7	−3.2	64	30	42	−7	17	12	48	21	15	66	0.72	+0.4	4	4,471	nw.	35	nw.	3	21	7	3	3.5	9.7	0.0
Concordia	1,392	50	58	28.64	30.18	+.04	23.0	−3.4	50	30	32	−3	17	14	29	20	17	80	0.13	−0.6	3	4,852	w.	28	n.	26	14	7	10	4.5	1.8	T.
Dodge City	2,509	11	51	27.49	30.20	+.09	28.8	−0.2	64	25	42	−3	27	16	37	23	20	82	0.07	−0.4	3	6,610	nw.	35	n.	25	20	7	4	2.7	1.6	T.
Wichita	1,358	139	158	28.67	30.17	+.04	26.2	−5.1	56	25	36	2	27	16	30	23	20	80	0.76	0.0	5	8,462	n.	44	nw.	28	14	10	7	4.1	9.0	0.0
Broken Arrow	765	11	52	29.31	30.16		34.0		63	25	43	3	27	25	36				1.81		6	8,653	n.	42	n.	26	12	7	12	5.2	8.1	T.
Muskogee	652	4					37.2		66	25	47	9	27	28	34				1.90		7		se.				15	5	11		6.0	0.0
Oklahoma City	1,214	10	47	28.85	30.18	+.07	34.2	−2.2	67	25	44	5	27	25	37	30	26	79	0.42	−0.9	6	7,899	n.	34	n.	26	15	7	9	4.4	2.1	0.0
Southern Slope							**40.8**	**−1.9**										**59**	**0.34**	**−0.4**									**3.4**		
Abilene	1,738	10	52	28.29	30.15	+.06	42.0	−2.2	75	24	55	15	27	29	42	33	24	59	0.31	−0.6	3	7,031	s.	31	s.	31	15	7	9	4.3	3.1	0.0
Amarillo	3,676	10	49	26.30	30.14	+.08	36.0	+0.7	70	25	50	4	27	22	41	27	20	65	0.51	−0.1	4	7,286	nw.	30	s.	14	22	5	4	3.3	4.0	0.0
Del Rio	944	64	71	29.13	30.14	+.08	49.2	−3.1	73	26	61	25	19	37	40				0.04	−0.8	2	6,889	se.	46	n.	26	20	5	6	3.6	0.0	0.0
Roswell	3,566	75	85	26.42	30.12	+.08	36.2	−3.0	73	31	53	11	27	20	51	28	17	52	0.48	+0.1	3	4,960	n.	42	nw.	11	23	4	4	2.4	4.3	0.0
Southern Plateau							**39.6**	**−1.1**										**50**	**0.15**	**−0.6**									**1.8**		
El Paso	3,762	110	133	26.25	30.10	+.09	41.8	−3.2	70	31	56	19	13	28	39	32	16	39	0.03	−0.5	1	5,487	nw.	39	w.	15	24	6	1	1.8	0.2	0.0
Santa Fe	7,013	38	53	23.22	30.17	+.13	25.4	−3.4	51	30	36	0	12	15	30	20	15	68	0.39	−0.2	4	4,487	ne.	22	ne.	3	20	7	4	2.8	5.7	T.
Flagstaff	6,907	10	59	23.35	30.14	+.09	23.4	−3.3	52	30	40	−10	12	6	49	18			0.13		2	4,830	w.	32	e.	10	25	3	3		1.7	1.0
Phoenix	1,108	10	82	28.92	30.10	+.07	52.0	+0.8	81	30	68	26	11	36	39	40	27	43	0.03	−1.1	1	2,871	e.	28	n.	9	27	0	4	1.4	0.0	0.0
Yuma	141	9	54	29.95	30.10	+.05	53.8	−0.6	80	30	68	31	11	40	36	42	25	34	0.01	−0.4	1	4,288	n.	27	n.	16	27	3	1	1.2	0.0	0.0
Independence	3,957	5	25	26.11	30.22	+.15	41.1	+2.9	70	30	55	19	10	28	35	32			0.30	−0.6	1		nw.				17	10	4	2.0	T	0.0
Middle Plateau							**27.0**	**−1.2**										**71**	**0.36**	**−0.7**									**5.4**		
Reno	4,532	74	81	25.57	30.20	+.07	36.8	+4.3	61	29	48	12	16	25	35	31	24	63	0.16	−1.6	3	4,100	w.	35	w.	30	12	13	6	4.5	1.5	0.0
Tonopah	6,090	12	20	24.11	30.18		32.6		54	30	40	12	7	26	24	27	20	61	0.02		1		se.									
Winnemucca	4,344	18	56	25.73	30.23	+.07	31.4	+2.8	59	29	41	3	16	21	34	28	25	76	0.53	−0.5	10	5,093	sw.	27	sw.	31	8	5	18	6.8	2.5	0.0
Modena	5,479	10	43	24.69	30.22	+.12	24.4	−2.3	55	29	38	−2	16	11	36	21	16	72	0.05	−0.7	2	6,039	w.	35	ne.	15	17	8	6	3.6	0.5	0.0
Salt Lake City	4,360	163	203	25.72	30.22	+.08	28.9	−0.3	54	30	36	12	16	22	22	25	21	74	0.60	−0.8	9	3,346	s.	33	nw.	25	9	6	16	6.8	5.5	3.1
Grand Junction	4,602	60	68	25.54	30.30	+.24	13.4	−10.6	39	26	26	−17	10	1	35	12	9	81	0.48	0.0	11	2,098	nw.	16	sw.	10	11	11	9	5.1	5.7	0.6
Northern Plateau							**33.4**	**+4.7**										**80**	**1.45**	**−0.2**									**8.4**		
Baker	3,471	48	53	26.50	30.18	+.02	28.5	+3.6	47	31	35	9	15	22	21	26	24	84	1.07	−0.3	16	5,002	se.	31	s.	7	1	6	24	8.3	12.9	1.0
Boise	2,739	78	86	27.30	30.24	+.05	32.6	+2.8	54	30	39	12	16	26	25	30	26	78	2.00	+0.1	18	3,013	se.	24	sw.	22	1	5	25	8.4	3.9	0.0
Lewiston	757	40	48	29.25	30.08	−.08	40.0	+7.5	60	30	46	26	16	34	19				1.34	−0.2	18	3,717	e.	36	nw.	2	0	5	26	9.0	T.	0.0
Pocatello	4,477	60	68	25.54	30.20	.00	27.5	+2.8	51	30	34	0	17	21	29	25	22	78	1.15	+0.5	11	9,515	se.	40	sw.	3	1	12	18	8.0	7.7	T.
Spokane	1,929	101	110	27.95	30.06	−.06	30.5	+3.0	48	18	37	5	15	24	21	30	28	87	1.89	−0.4	21	5,166	sw.	30	w.	2	1	5	25	8.6	11.0	0.0
Walla Walla	991	57	65	29.00	30.09	−.06	41.0	+8.3	61	21	47	20	16	35	29	37	32	72	1.26	−0.8	16	5,108	s.	29	w.	5	3	3	25	8.3	4.1	0.0
North Pacific Coast Region							**43.5**	**+3.1**										**86**	**6.69**	**−0.1**									**8.4**		
North Head	211	11	56	29.83	30.06	+.01	43.4	+1.3	50	22	47	35	24	40	11	42	40	89	8.26	+1.6	26	16,084	s.	80	s.	18	0	4	27	9.4	0.0	0.0
Port Angeles	29	8	53		30.02		40.6		57	18	46	27	26	35	22				4.40	−1.1	24	5,559	s.	42	w.	7	1	10	20		T.	0.0
Seattle	125	215	250	29.92	30.06	+.01	42.6	+3.1	53	29	46	31	15	39	12	40	37	83	4.97	+0.1	24	9,303	s.	56	s.	7	0	4	27	9.0	T.	0.0
Tacoma	194	172	201	29.84	30.06	+.02	42.2	+3.4	54	30	46	29	15	38	15				5.55	−0.6	24	7,883	s.	43	sw.	7	0	5	26	8.9	T.	0.0
Tatoosh Island	86	9	53	29.87	29.97	−.01	42.2	+1.0	50	29	45	34	13	39	12	41	39	88	12.42	+0.3	28	15,632	s.	72	s.	19	1	7	23	8.6	0.0	0.0
Yakima	1,071	5					32.7		58	31	43	4	15	22	42				0.71		7		ne.				6	11	14	6.5	6.9	0.0
Medford	1,425	4					41.1		60	30	48	24	16	34	23	39	36	85	1.70		20		nw.	12	sw.	22	1	3	27	7.4	0.0	0.0
Portland, Oreg	153	68	106	29.95	30.11	+.03	44.8	+5.4	58	29	49	29	16	40	16	42	40	83	6.94	+0.4	27	5,525	sw.	28	sw.	7	1	2	28	9.2	T.	0.0
Roseburg	510	9	57	29.63	30.19	+.09	45.8	+4.6	61	29	52	31	15	40	23	43	41	85	4.26	−1.4	25	2,028	s.	24	sw.	13	0	8	23	8.3	0.0	0.0
Middle Pacific Coast Region							**48.5**	**+0.8**										**82**	**1.68**	**−2.8**									**5.8**		
Eureka	62	73	89	30.18	30.25	+.15	48.2	+1.3	61	22	54	33	7	43	17	46	44	87	3.97	−3.7	21	3,810	se.	31	w.	13	1	10	20	7.9	0.0	0.0
Point Reyes	490	7	18	29.63	30.15		49.6	+0.2	64	21	53	42	11	46	20				1.58		7	14,011	nw.	61	nw.	6	14	4	13	5.4	0.0	0.0
Red Bluff	332	50	56	29.86	30.23	+.11	46.0	+0.2	64	19	53	31	8	39	27	43	39	77	0.95	−3.0	4	3,667	nw.	24	nw.	15	11	6	14	6.0	0.0	0.0
Sacramento	69	106	117	30.15	30.22	+.10	47.0	+1.2	63	23	54	29	9	40	23	44	42	82	1.02	−2.7	7	4,851	se.	26	nw.	15	10	12	9	5.0	0.0	0.0
San Francisco	155	208	243	30.04	30.21	+.10	51.4	+1.5	66	23	57	40	9	46	17	47	44	80	1.62	−2.7	6	4,027	nw.	29	se.	25	13	8	10	5.1	0.0	0.0
San Jose	141	12	110	30.07	30.23		48.9	+0.6	67	22	59	29	16	39	32				0.86	−2.0	5	3,530	nw.	30	se.	25	11	9	11	5.2	0.0	0.0
South Pacific Coast Region							**53.5**	**+1.8**										**64**	**1.00**	**−1.8**									**3.5**		
Fresno	327	89	98	29.86	30.23	+.13	48.0	+1.8	71	23	56	30	13	40	33	45	42	82	0.95	−0.6	3	2,961	nw.	20	nw.	14	10	10	11	5.7	0.0	0.0
Los Angeles	338	159	191	29.75	30.12	+.04	57.6	+3.0	78	21	67	42	11	48	24	47	37	53	0.20	−2.6	2	3,714	ne.	16	nw.	14	21	6	4	2.5	0.0	0.0
San Diego	87	62	70	30.02	30.11	+.04	54.4	+0.1	72	20	63	40	9	46	28	47	39	63	0.08	−1.9	2	3,387	nw.	28	w.	14	18	8	5	3.2	0.0	0.0
San Luis Obispo	201	32	40	29.96	30.18	+.09	54.1	+2.5	78	20	65	32	17	43	37	45	37	57	2.78	−1.9	4	3,658	n.	26	ne.	6	22	5	4	2.6	0.0	0.0
West Indies																															
San Juan, P. R	82	9	54	29.99	30.08		74.6	−0.4	81	5	80	65	24	69	15				3.16	−1.5	23	9,825	e.	38	e.	2	8	22	1	4.7	0.0	0.0
Panama Canal																															
Balboa Heights	118	7	97	29.73	29.85	.00	78.2	−1.7	88	7	86	67	27	70	19	72	71	89	1.44	+0.5	8	6,371	nw.	26	n.	31	8	19	4	5.3	0.0	0.0
Colon	36	7	97	29.83	29.87	.00	79.8	−0.2	86	7	84	72	2	75	13	74	73	83	3.66	0.0	12	9,159	n.	30	ne.	14	7	15	9	5.5	0.0	0.0
Alaska																															
Juneau	80	11	54				19.9		40	1	23	0	23	17	10	19	15	80	5.82		27	7,824	s.	32	e.	29	3	1	27	9.0	53.9	20.6

TABLE 2.—*Data furnished by the Canadian Meteorological Service, January, 1925*

Stations	Altitude above mean sea level, Jan. 1, 1919	Pressure			Temperature of the air						Precipitation		
		Station reduced to mean of 24 hours	Sea level reduced to mean of 24 hours	Departure from normal	Mean max. + mean min. ÷ 2	Departure from normal	Mean maximum	Mean minimum	Highest	Lowest	Total	Departure from normal	Total snowfall
	Feet	*In.*	*In.*	*In.*	*°F.*	*°F.*	*°F.*	*°F.*	*°F.*	*°F.*	*In.*	*In.*	*In.*
St. Johns, N. F.	125												
Sydney, C. B. I.	48	29.98	30.03	+.10	12.7	−7.8	21.4	4.0	41	−22	5.35	+0.25	42.5
Halifax, N. S.	88	29.97	30.08	+.11	16.2	−5.6	24.8	7.6	43	−15	3.89	−1.88	18.0
Yarmouth, N. S.	65	29.98	30.06	+.06	20.5	−5.8	27.4	13.7	45	−6	3.33	−2.08	20.1
Charlottetown, P. E. I.	38	30.01	30.05	+.09	9.5	−7.5	17.7	1.4	39	−17	2.77	−1.19	26.9
Chatham, N. B.	28	29.98	30.02	+.05	2.8	−7.0	14.0	−8.3	33	−43	3.14	−0.45	31.3
Father Point, Que.	20	30.11	30.14	+.16	1.0	−7.0	8.3	−6.3	25	−27	3.02	+0.17	30.2
Quebec, Que.	296	29.83	30.18	+.16	5.2	−3.9	12.2	−1.8	36	−22	3.27	−0.74	32.7
Montreal, Que.	187	29.95	30.18	+.14	8.5	−3.2	16.4	0.6	37	−16	4.12	+0.39	41.2
Stonecliffe, Ont.	489												
Ottawa, Ont.	236	29.92	30.21	+.18	6.4	−3.2	15.7	−2.8	40	−29	2.64	−0.35	26.4
Kingston, Ont.	285	29.85	30.19	+.14	12.8	−4.3	21.2	4.3	38	−20	1.31	−2.14	13.1
Toronto, Ont.	379	29.74	30.17	+.12	20.7	−0.7	29.1	12.4	40	−11	2.00	−0.92	20.0
Cochrane, Ont.	930				−4.6		5.1	−14.2	30	−35	T.		T.
White River, Ont.	1,244	28.69	30.09	+.08	−2.7	−2.3	11.9	−17.3	32	−50	1.43	−0.26	14.3
Port Stanley, Ont.	592												
Southampton, Ont.	656				16.8	−3.6	24.5	9.1	36	−20	2.06	−1.99	20.6
Parry Sound, Ont.	688	29.40	30.15	+.14	12.1	−1.7	22.8	1.4	36	−28	1.86	−2.22	18.6
Port Arthur, Ont.	644	29.37	30.12	+.05	7.6	+4.5	14.5	0.8	38	−23	0.82	0.00	8.2
Winnipeg, Man.	760												
Minnedosa, Man.	1,690												
Le Pas, Man.	860				−11.0		−1.6	−20.3	20	−42	0.41		4.1
Qu'Appelle, Sask.	2,115	27.64	30.01	−.07	3.8	+7.6	13.8	−6.1	42	−28	0.94	+0.44	9.4
Medicine Hat, Alb.	2,144	27.55	29.90	−.17	14.1	+8.6	22.6	5.5	46	−28	0.26	−0.31	2.6
Moose Jaw, Sask.	1,759				6.4		15.6	−2.8	42	−26	0.85		8.5
Swift Current, Sask.	2,392	27.36	30.03	−.06	9.5	+6.4	18.7	0.3	41	−24	0.87	+0.23	8.7
Calgary, Alb.	3,428	26.23	29.98	−.05	12.6	+4.2	23.0	2.2	47	−20	0.36	−0.17	3.6
Banff, Alb.	4,521	25.17	29.93	−.07	15.5	+3.4	23.2	7.8	42	−20	1.34	+0.15	13.4
Edmonton, Alb.	2,150	27.52	29.93	−.10	4.0	+2.2	12.1	−4.1	43	−30	0.98	+0.30	9.8
Prince Albert, Sask.	1,450	28.41	30.10	+.01	−5.1	+3.3	5.1	−15.3	22	−42	0.43	−0.54	4.3
Battleford, Sask.	1,592	28.18	30.04	−.04	−2.3	+3.6	6.0	−10.6	36	−38	0.49	+0.09	4.9
Kamloops, B. C.	1,262												
Victoria, B. C.	230	29.74	30.00	+.03	40.8	+2.3	44.1	37.6	50	31	5.00	−0.39	0.9
Barkerville, B. C.	4,180												
Hamilton, Ber.	151	30.06	30.23	+.10	63.7	+1.7	68.5	59.0	73	49	4.06	−0.88	0.0
Prince Rupert, B. C.	170												

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St. Johns, N. F.	125	29.51	29.65	−.18	24.4	−4.3	29.7	19.1	45	5	2.82	−2.21	24.0
Sydney, C. B. I.	48	29.84	29.89	.00	24.4	−3.8	30.0	18.8	48	4	3.19	−1.44	12.5
Medicine Hat, Alb.	2,144	27.79	30.19	+.22	6.5	−11.7	14.6	−1.5	55	−38	1.24	+0.69	12.4
Calgary, Alb.	3,428	26.47	30.27	+.33	7.7	−10.5	17.1	−1.6	53	−45	2.24	+1.65	22.4
Edmonton, Alb.	2,150	27.79	30.24	+.31	1.3	−11.8	8.2	−5.6	43	−45	1.61	+0.91	16.1
Banff, Alb.	4,521	25.38	30.28	+.34	2.3	−16.8	11.1	−6.4	43	−54	3.76	+2.55	28.5

Chart I. Tracks of Centers of Anticyclones, January, 1925. (Inset) Departure of Monthly Mean Pressure from Normal

Chart I. Tracks of Centers of Anticyclones, January, 1925. (Inset) Departure of Monthly Mean Pressure from Normal

(Plotted by Wilfred P. Day)

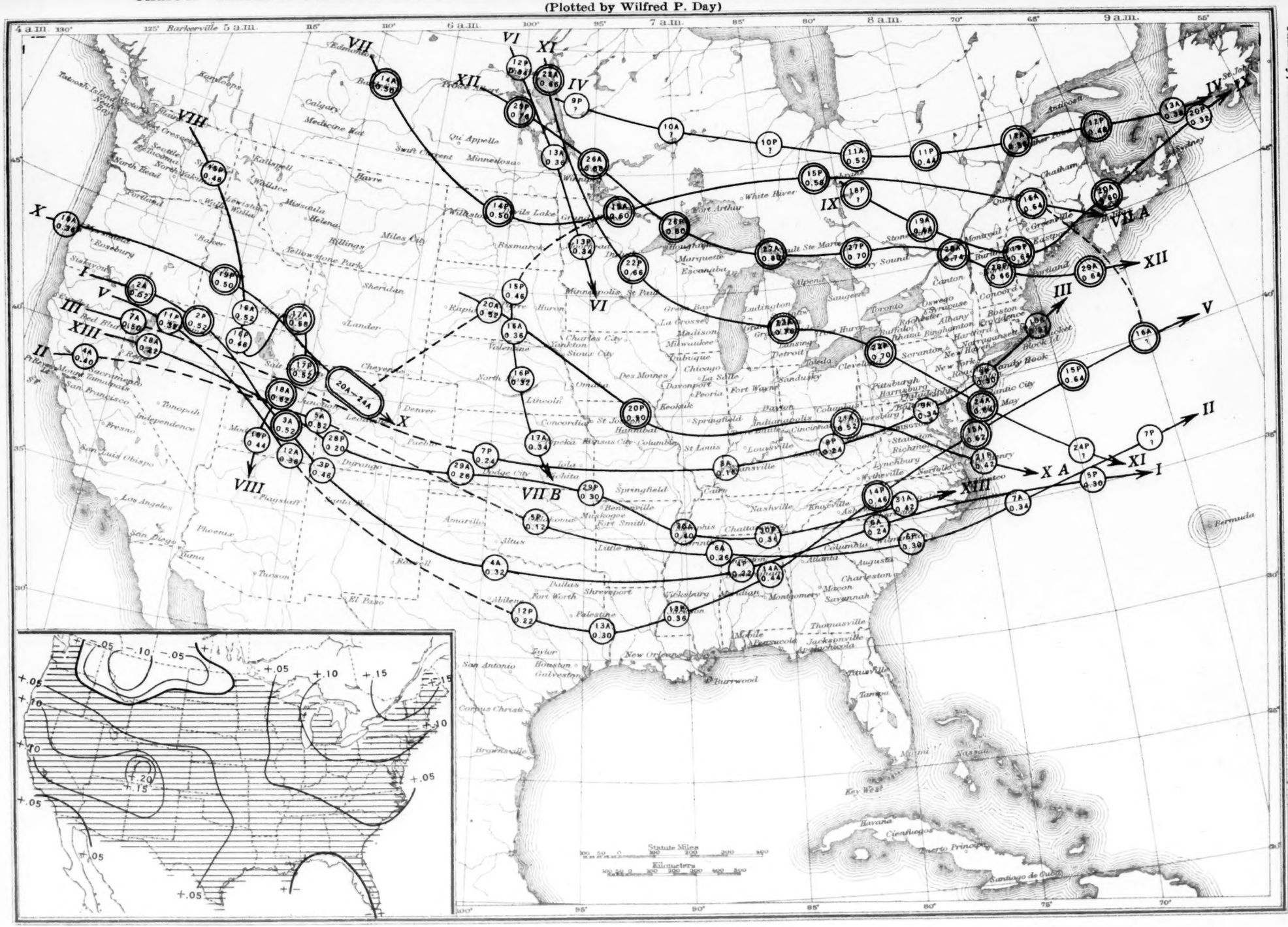

Chart II. Tracks of Centers of Cyclones, January, 1925. (Inset) Change in Mean Pressure from Preceding Month

(Plotted by Wilfred P. Day)

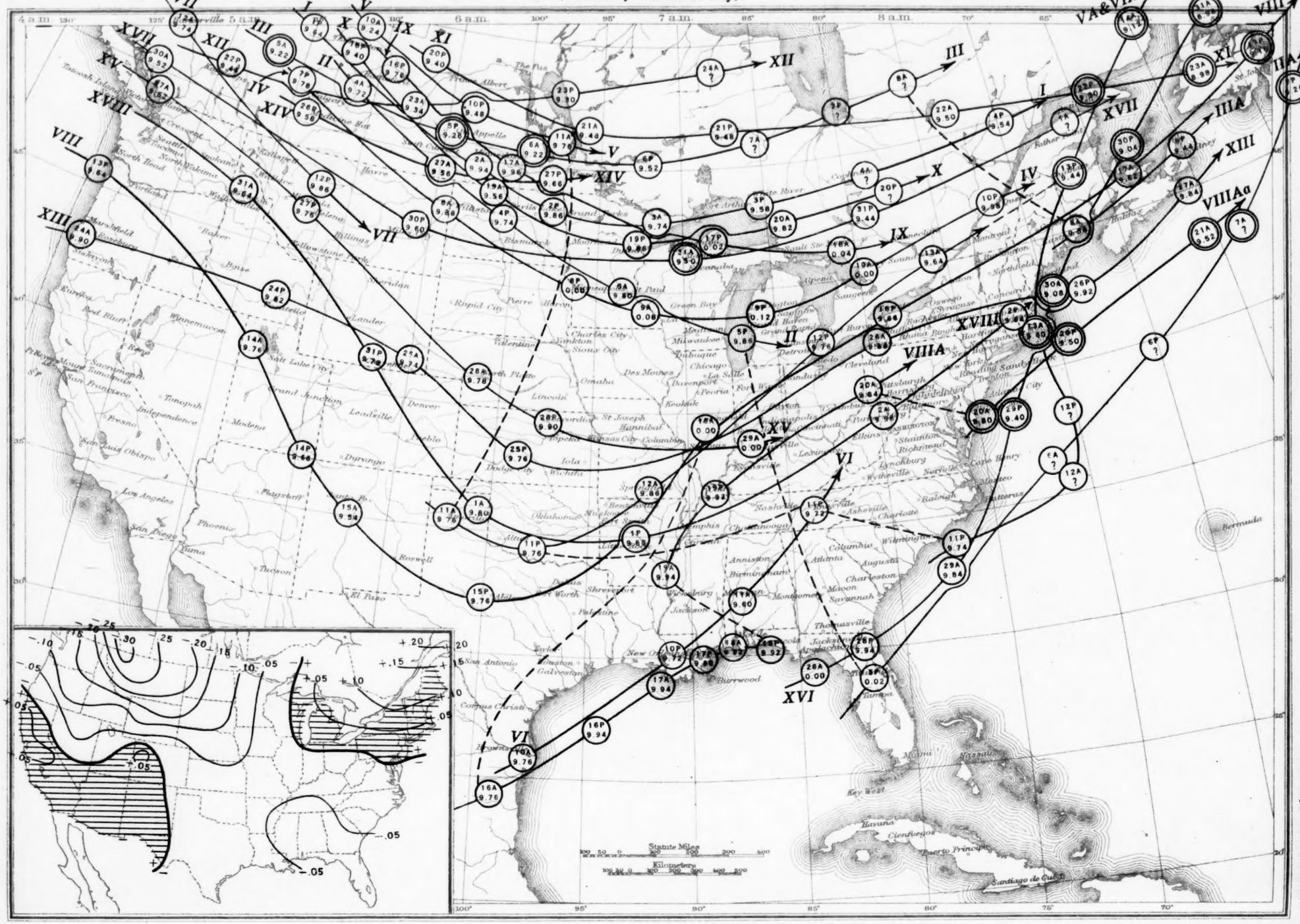

Chart III. Departure (°F.) of the Mean Temperature from the Normal, January, 1925

Chart III. Departure (°F.) of the Mean Temperature from the Normal, January, 1925

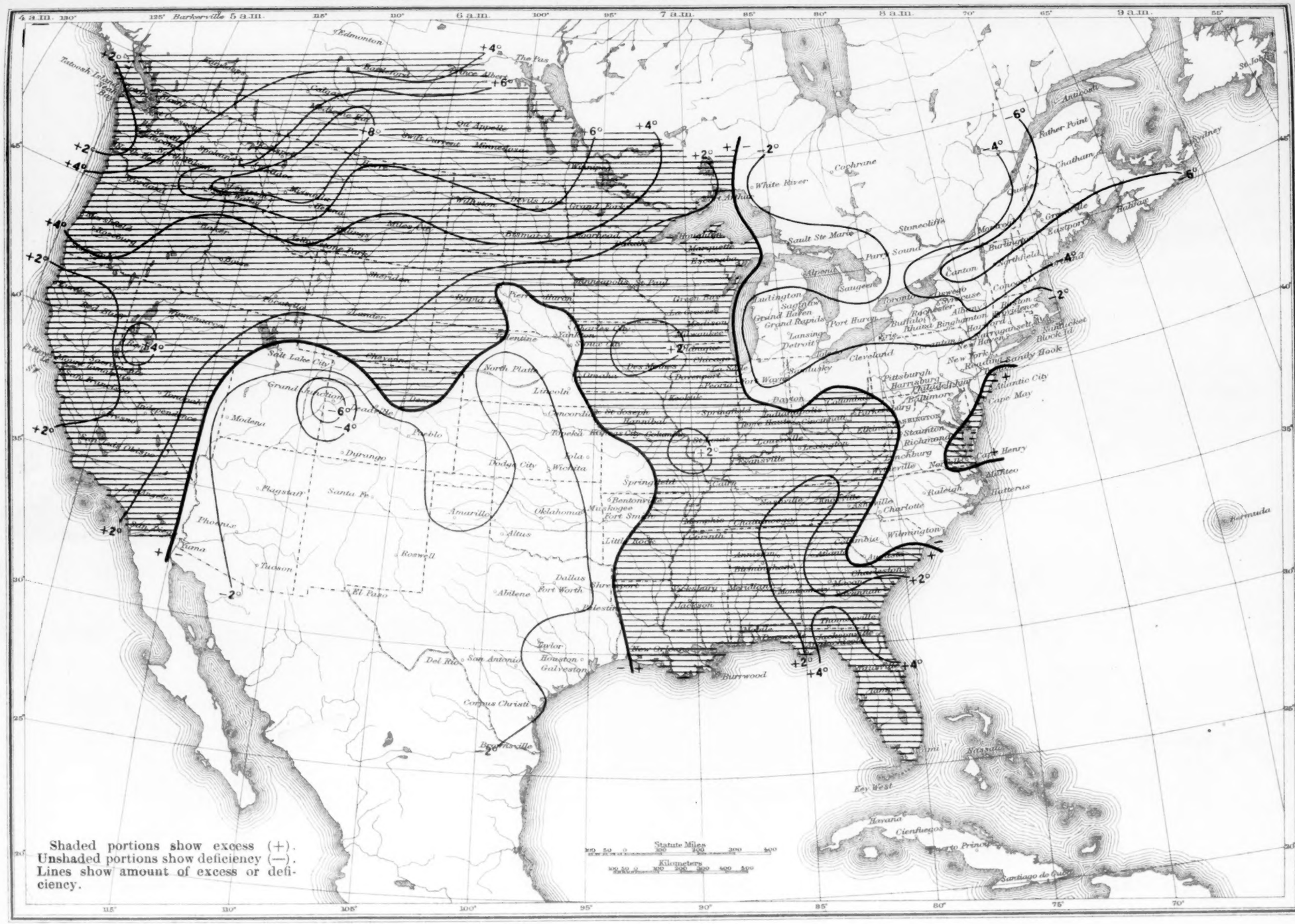
Shaded portions show excess (+).
Unshaded portions show deficiency (—).
Lines show amount of excess or deficiency.
Statute Miles
Kilometers

Chart IV. Total Precipitation, Inches, January, 1925. (Inset) Departure of Precipitation from Normal

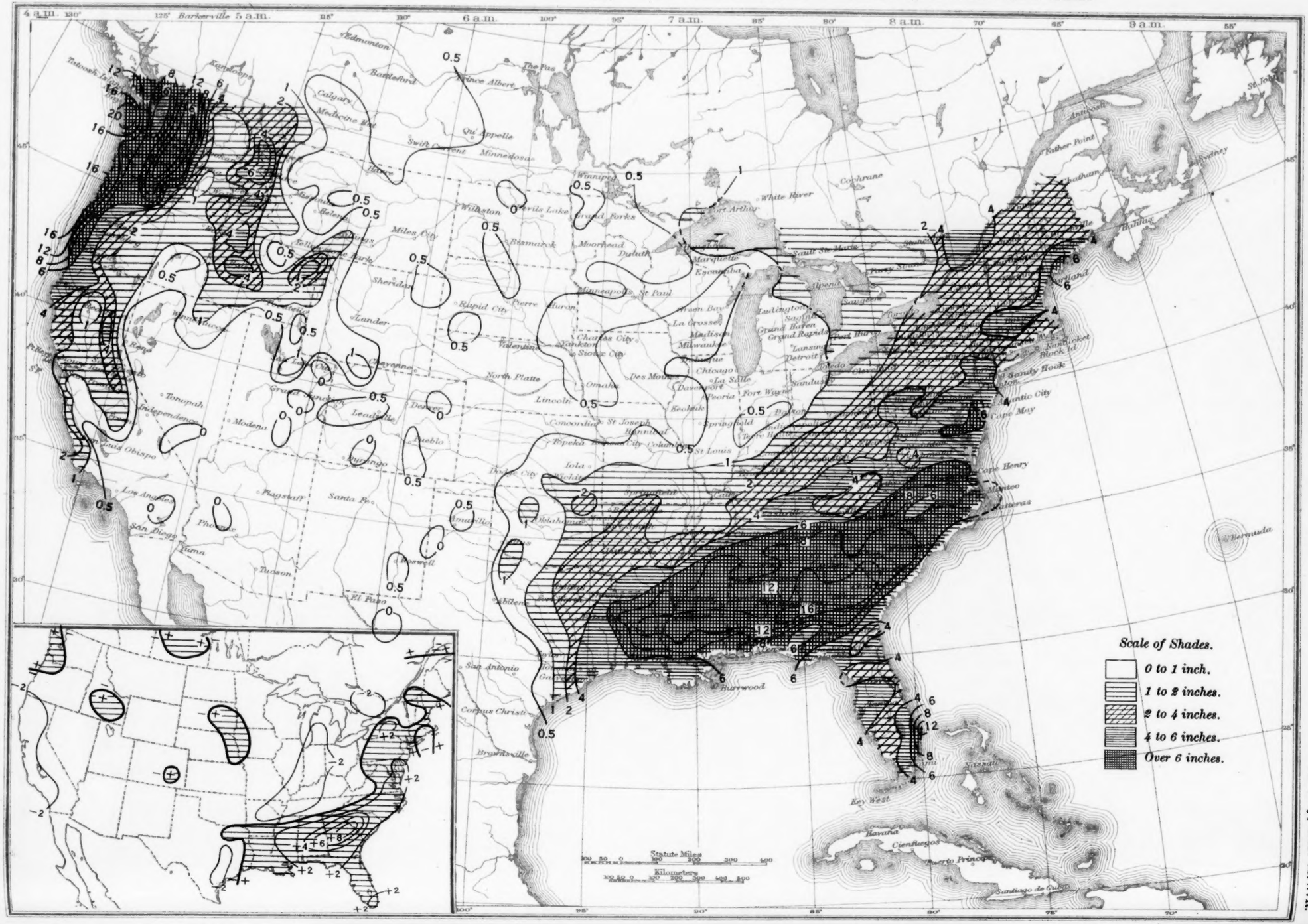

Chart V. Percentage of Clear Sky between Sunrise and Sunset, January, 1925

Chart V. Percentage of Clear Sky between Sunrise and Sunset, January, 1925

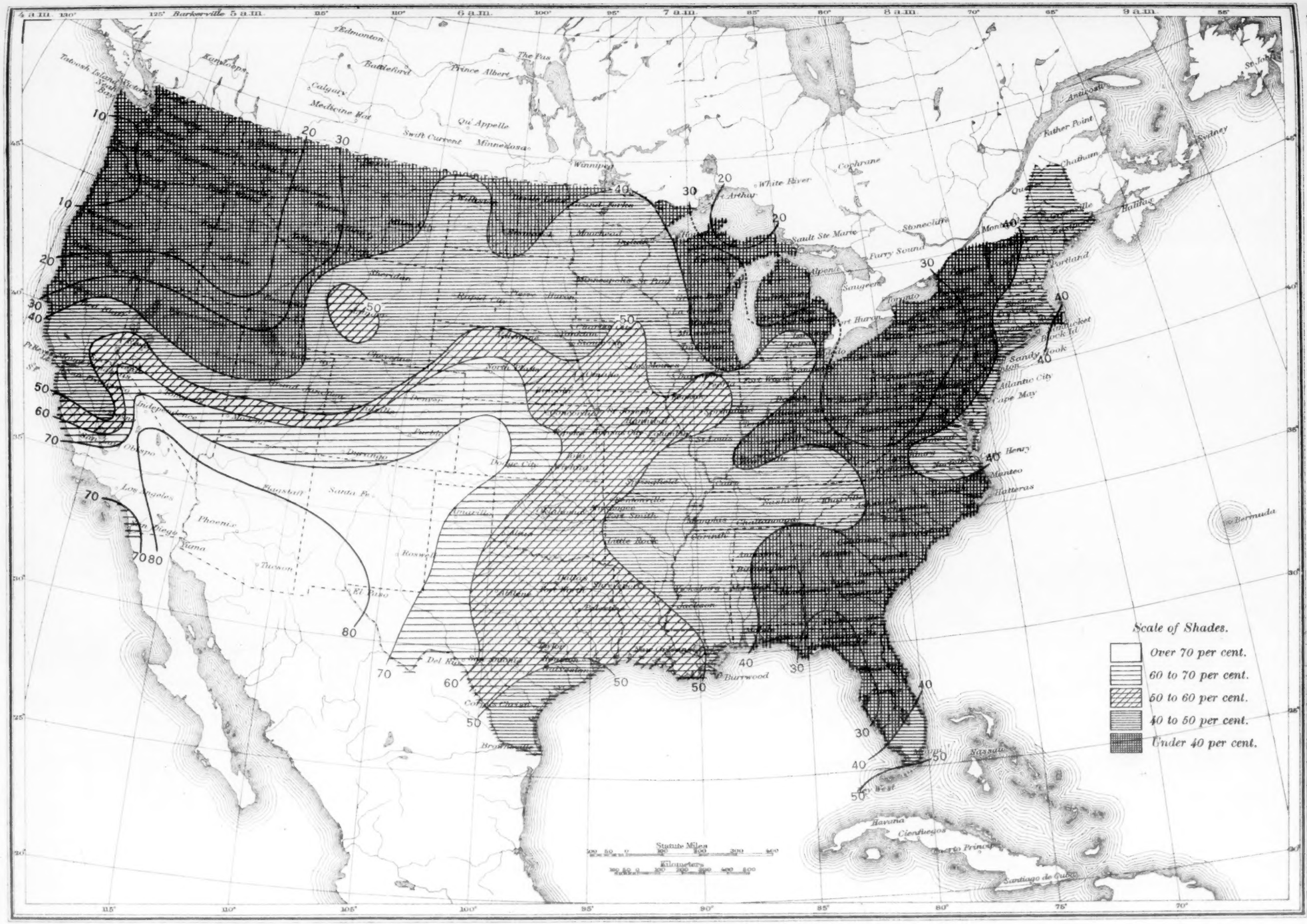

Chart VI. Isobars at Sea level and Isotherms at Surface; Prevailing Winds, January, 1925

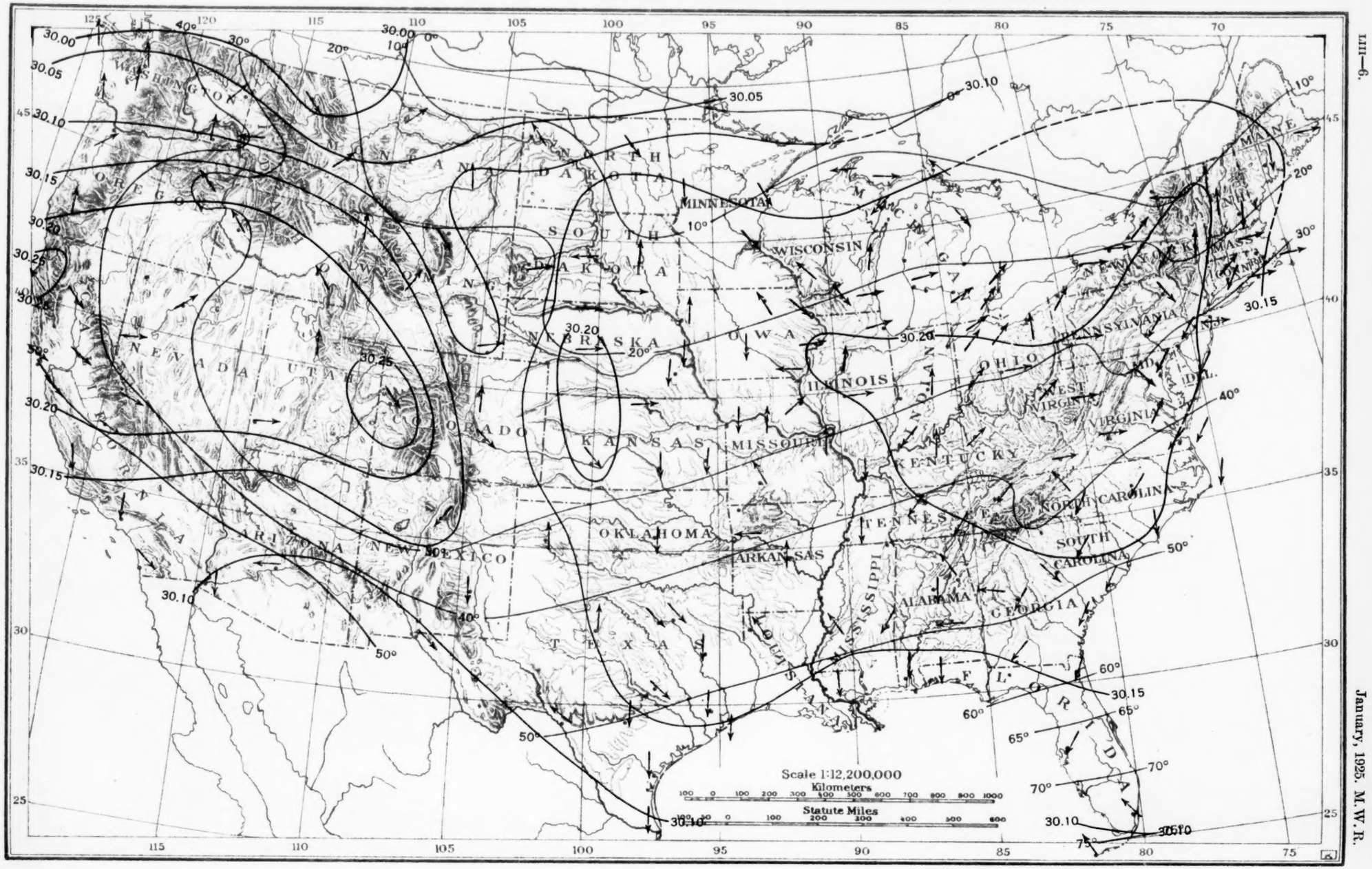

Chart VII. Total Snowfall, Inches, January, 1925. (Inset) Depth of Snow on Ground at end of Month

Chart VII. Total Snowfall, Inches, January, 1925. (Inset) Depth of Snow on Ground at end of Month

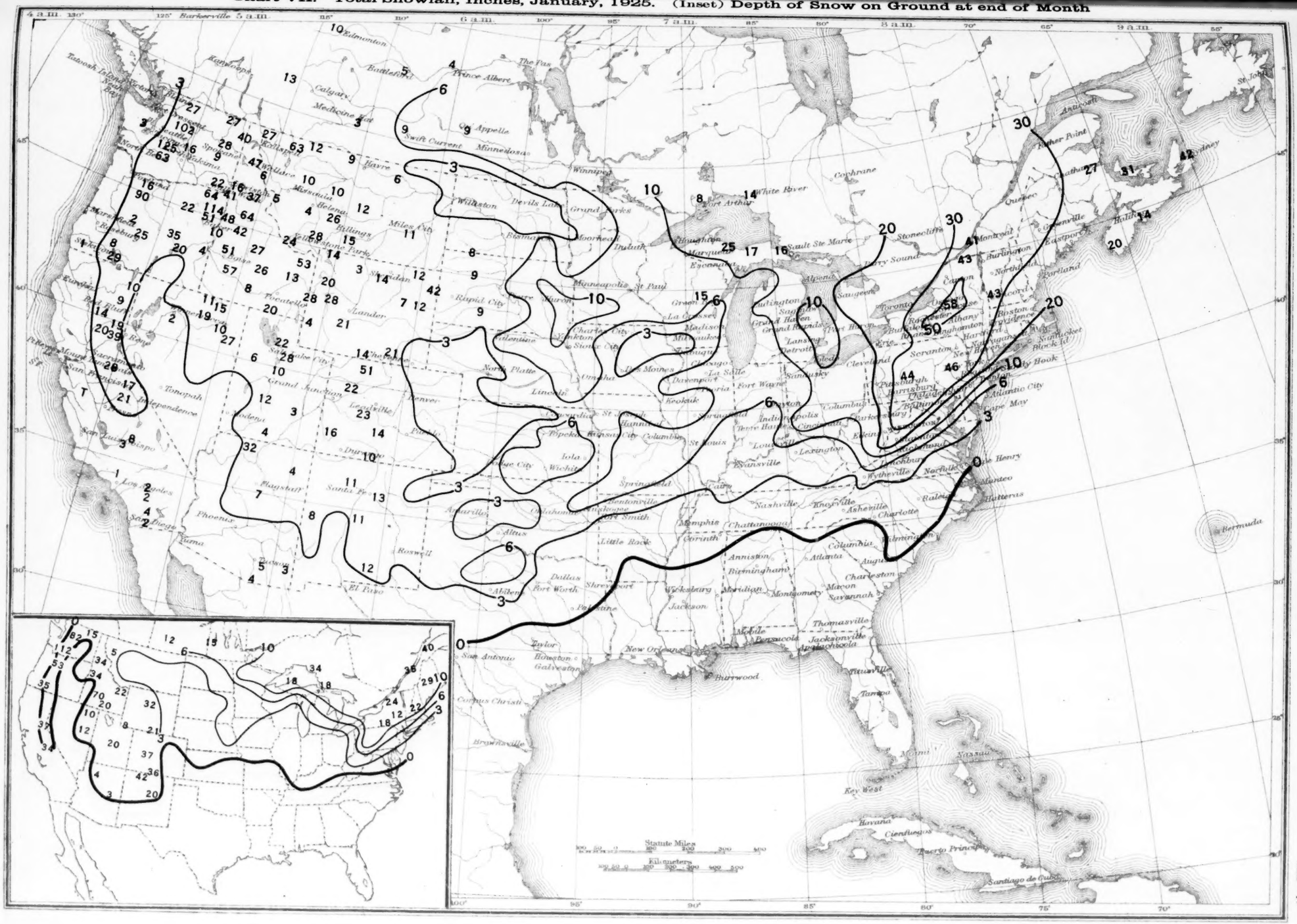

Chart VIII. Weather Map of North Atlantic Ocean, January 4, 1926
(Drawn by R. A. Young)

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Chart VIII. Weather Map of North Atlantic Ocean, January 7, 1925

(Plotted by F. A. Young)

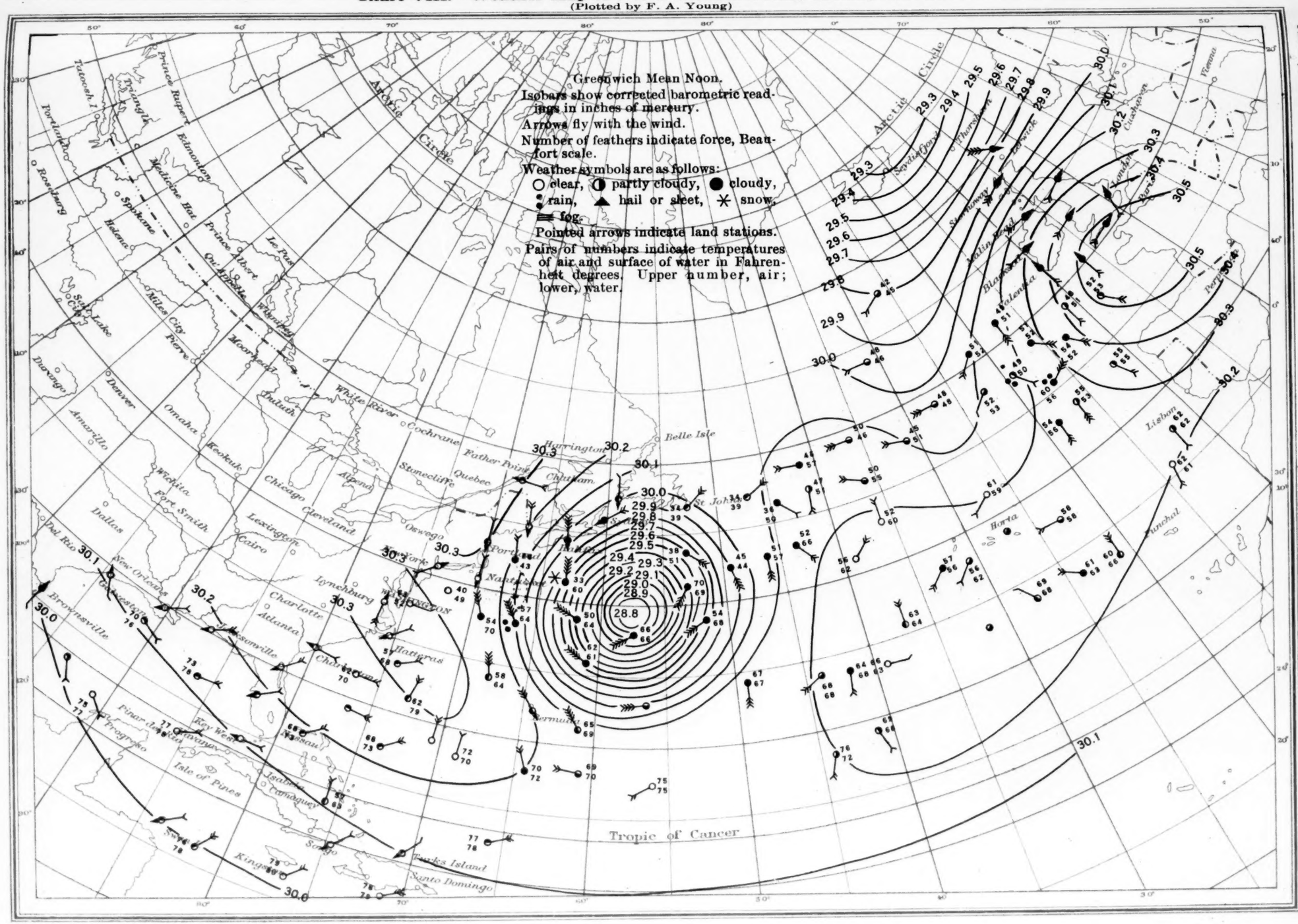


Chart IX. Weather Map of North Atlantic Ocean, January 8, 1925

(Plotted by F. A. Young)

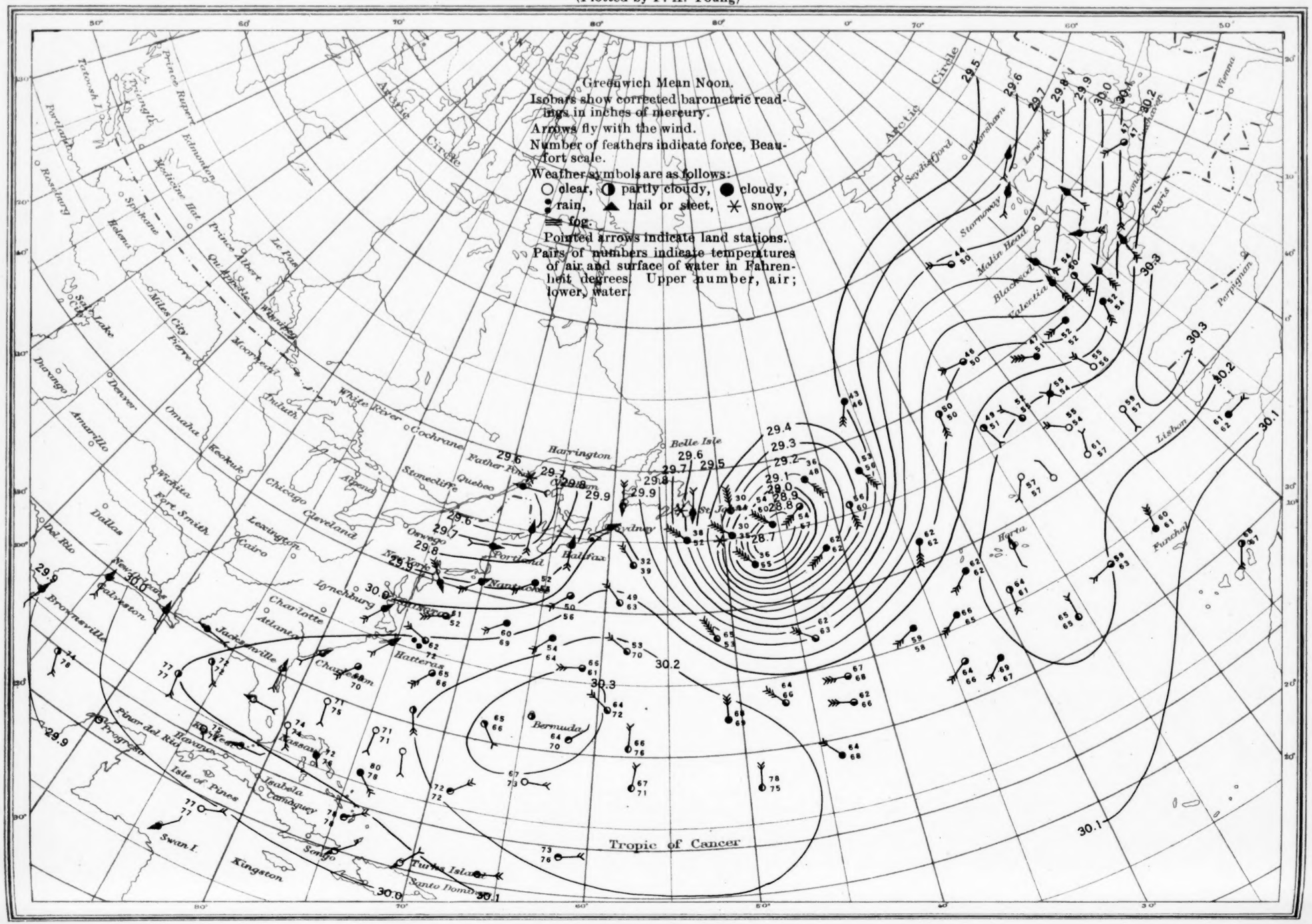


Chart X. Weather Map of North Atlantic Ocean, January 9, 1925

(Plotted by F. A. Young)

Chart X. Weather Map of North Atlantic Ocean, January 9, 1925
(Plotted by F. A. Young)

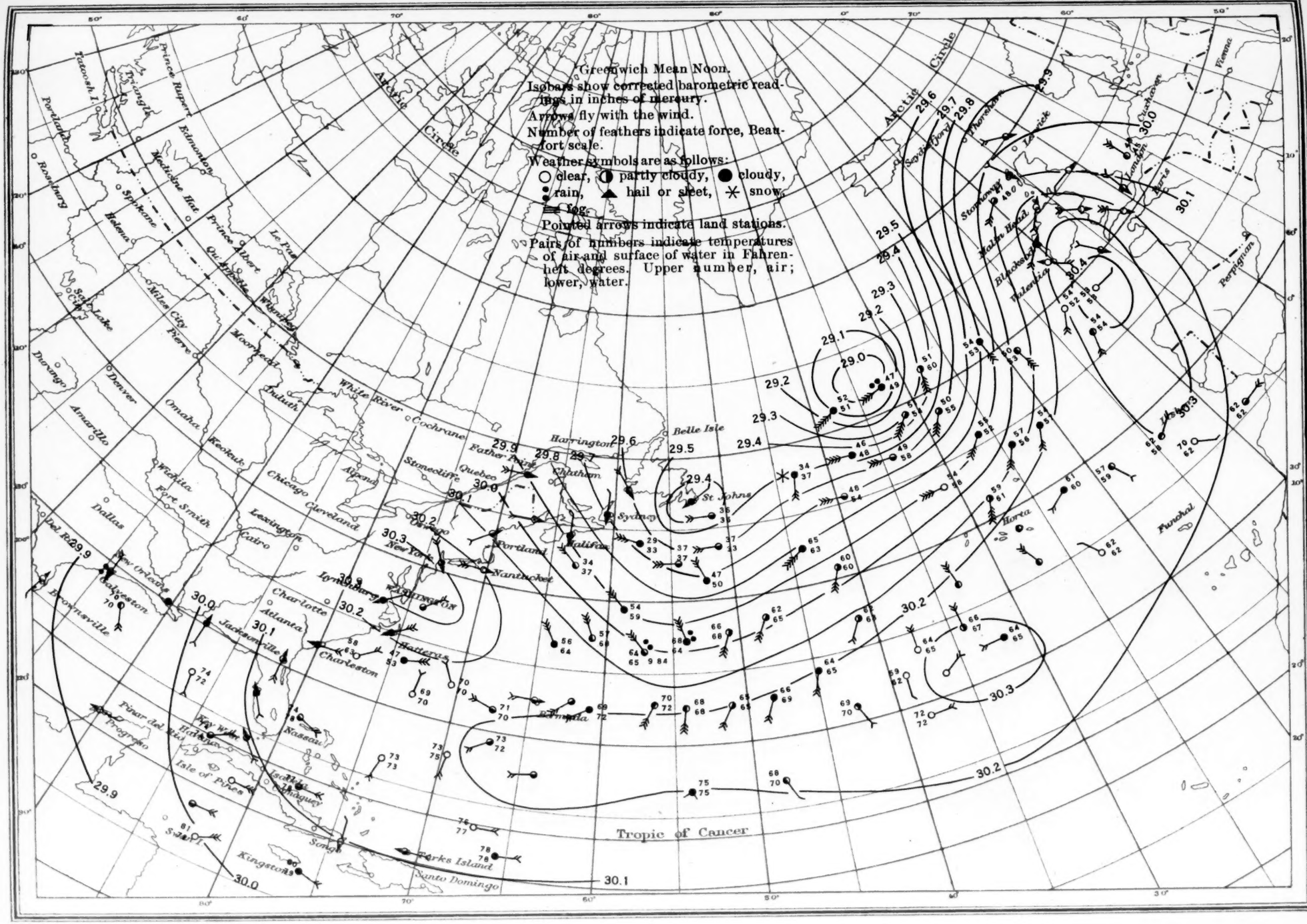
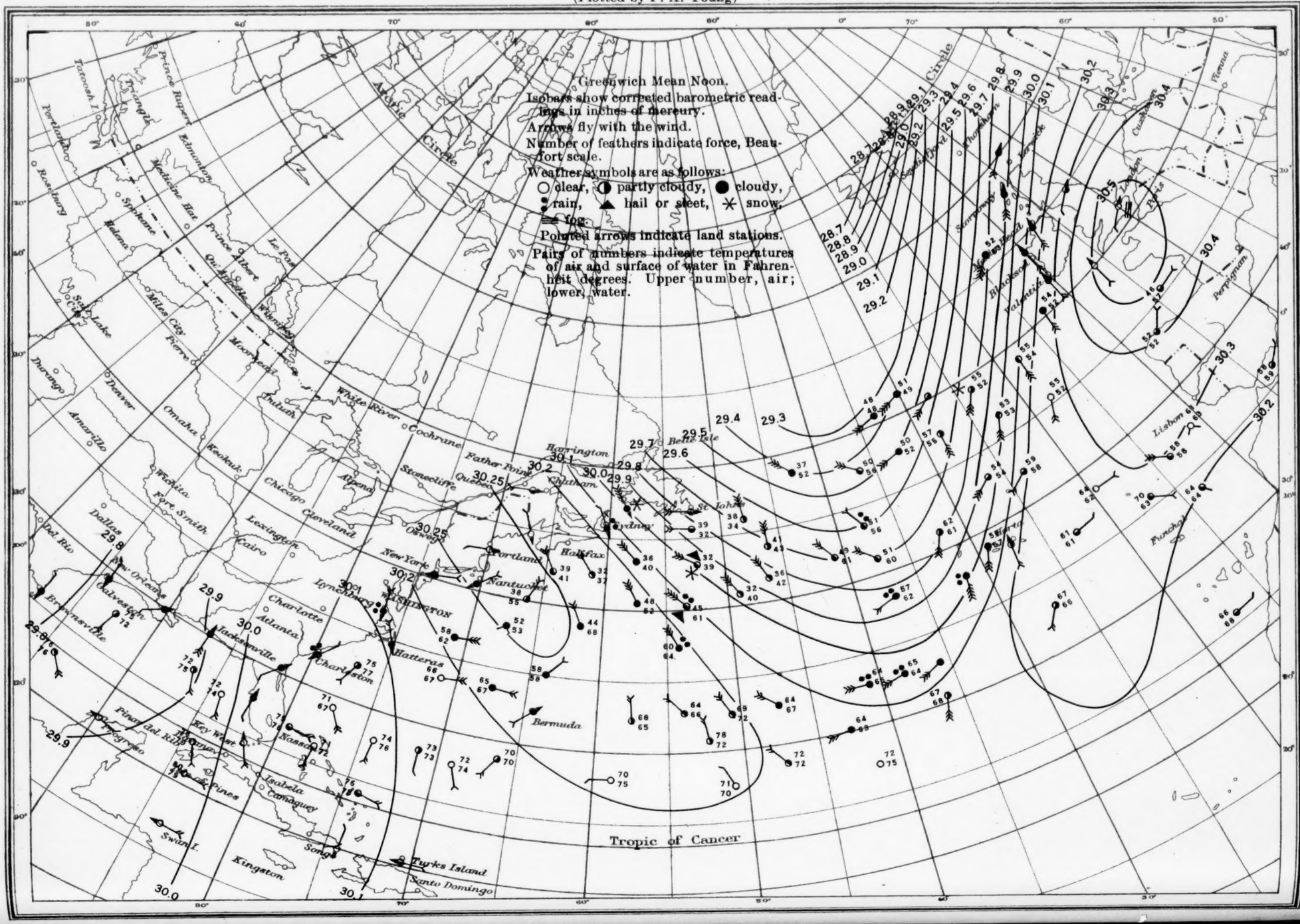

Greenwich Mean Noon.
Isobars show corrected barometric readings in inches of mercury.
Arrows fly with the wind.
Number of feathers indicate force, Beaufort scale.
Weather symbols are as follows:
clear, partly cloudy, cloudy,
rain, hail or sleet, snow,
fog.
Pointed arrows indicate land stations.
Pairs of numbers indicate temperatures of air and surface of water in Fahrenheit degrees. Upper number, air; lower, water.
Arctic Circle
Tropic of Cancer
Belle Isle
Harrington
Father Point
Quebec
Cochrane
Stmecliffe
Chatham
St. Johns
Sydney
Halifax
Portland
Nantucket
New York
Washington
Hatteras
Bermuda
Nassau
Charleston
Jacksonville
Atlanta
Charlotte
Cleveland
Chicago
Detroit
Buffalo
Toronto
Duluth
White River
Moorhead
Winnipeg
Prince Albert
Qu'Appelle
Prince Rupert
Edmonton
Medicine Hat
Swift Current
Calgary
Spokane
Helena
Miles City
Pierre
Omaha
Denver
Amarillo
Dallas
Wichita
Fort Smith
Kansas City
Cairo
Lexington
Indianapolis
Louisville
Columbus
Pittsburg
Harrisburg
Atlantic City
Baltimore
Washington
Norfolk
Cape Hatteras
Wilmington
Charleston
Savannah
Jacksonville
Tampa
Key West
Havana
Progreso
Isle of Pines
Kingston
Santo Domingo
Curaçao
Port of Spain
Barbados
Grenada
St. Lucia
Martinique
Dominica
Guadeloupe
Antigua
St. Kitts
Nevis
Montserrat
Santiago
Porto Rico
Turks Island
Inagua
Nassau
Bermuda
Halifax
Sydney
St. Johns
Belle Isle
Harrington
Father Point
Quebec
Cochrane
Stmecliffe
Chatham

Chart XI. Weather Map of North Atlantic Ocean, January 10, 1925

(Plotted by F. A. Young)